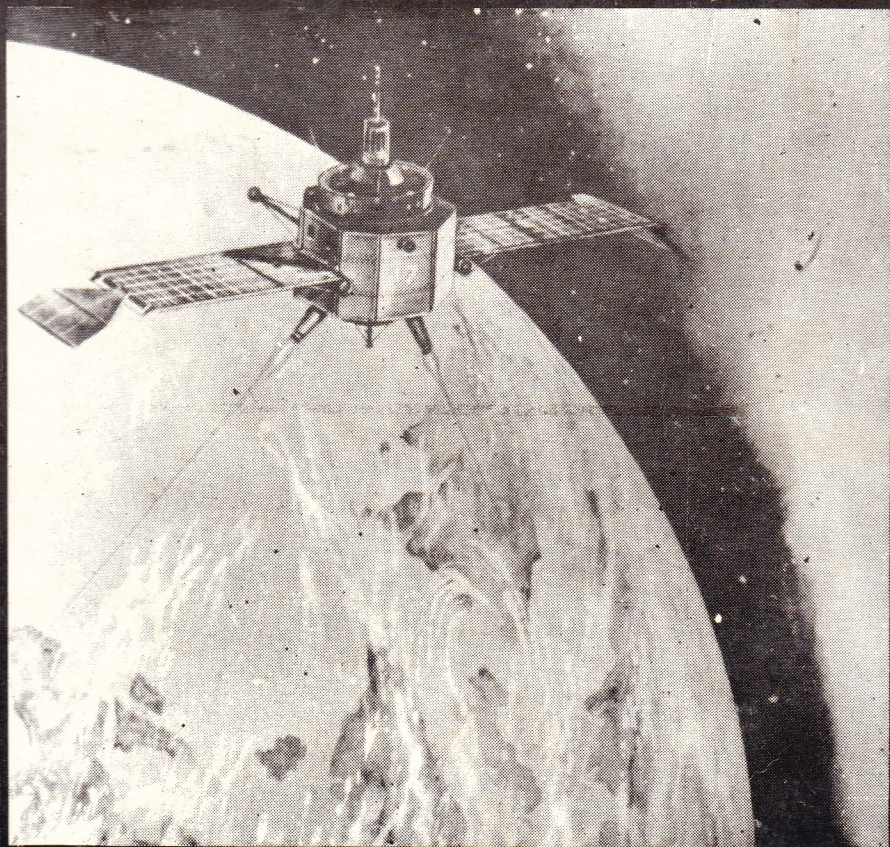


# SCANNING THE WORLD WITH AMATEUR RADIO



**A GUIDE TO ESTABLISHING  
YOUR HAM RADIO STATION**

**SANDEEP BARUAH  
VU2MSY**



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## FOREWORD

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While the ocean of high technology rolling in and the world turning into a global village, very few of us know that the forerunners in the field of communication were mostly amateurs (non-professionals). Now even in this era of heavy specialization in the field of electronics and telecommunication, we find people around the world who maintain great interest in home-made radio communication equipments and build their own radio communication network with entirely personal effort. They set up their own radio stations and put their signals into the air to be listened into and replied by their fellow radio operators around the world. While the shut-ins and lonely people literally travel across the continents and oceans by just sitting in their room and make everlasting friendship with unknown people of the distant unknown lands, the experiment oriented people get thrilled and excited to see the marvel of the equipments they have constructed with their own hands. Nowadays low cost wireless sets are made available by some amateur radio organizations or one can also go for importing commercial equipments meant for amateur radio operation.

To pursue a career in amateur radio, the radio enthusiast requires a government licence issued by the W.P.C. Wing of the Ministry of Communications, New Delhi by a licencing examination called the Amateur Radio Station Operator's Certificate (ASOC) Examination conducted at the Wireless Monitoring Stations Located all over the country.

This book is a brief profile on amateur radio. Keeping in view that amateur radio is very new in this part of the world, effort is made here to enable readers to get an all-round exposure on the subject. It describes the utility of amateur radio as a communication media and a specialized technical pursuit, gives hints and tips, ideas and information required to become an amateur radio operator. The author claims no originality in the book. It is rather a compilation for which various books, magazines and newsletters are consulted. The author is indebted to all those sources. Technical and non-technical (Radio regulations)- both these aspects are covered to some extent and a 'Question and Answer' section with a model question paper is included. I hope the novice will find the book useful to start with.

I am grateful to my parent without whose moral and financial support this compilation would not have seen light of the day. I am also grateful to Mr. N. K. Baruah (VU2NKB), and Mr. Ranjit Chaliha (VU2RCH) without whose constant support, encouragement and guidance it would not have been possible for me to come on-the-air. My special thanks goes to Mr. D. P. Dey (VU2DPD, Haldia port) for the care he has been taking so that a CW QRP operator like me is not missed from the band. My regards also to Mr. R. Chakravorty and Mr. R. Venkatachalam (VU2JRV) of Shillong Wireless Monitoring Station for their guardianly advice and help. I remain grateful to my friend SWL Alakesh Das, who made the Desk Top Publishing work done in his computer at *print21*.

Our venture will be a success if it leads more and more boys & girls into ham radio.

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Published by  
Mrs. Basanti Baruah  
Lachitnagar,  
Guwahati - 781 007.

FIRST EDITION : Guwahati Book Fair 1993.

© Author for EWG.

Price : Rs. 35.00 only

Computerised designing, layout & printed by  
Alakesh Das for **print21**, Ambikagiri Nagar  
Path, R G Baruah Road, Guwahati 781 024.



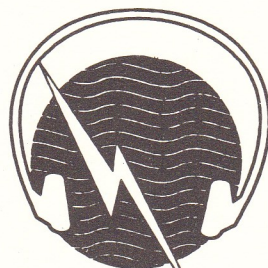
# SCANNING THE WORLD WITH **AMATEUR RADIO**

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*A comprehensive profile on Amateur Radio and a guide to establish your own wireless station with Questions & Answers for the Amateur Radio Operator's Certificate Examination conducted by the Ministry of Communications, New Delhi.*

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Written & compiled by  
**Sandeep Baruah, VU2MSY**



**ETHERIAL WHISPER  
GROUP**



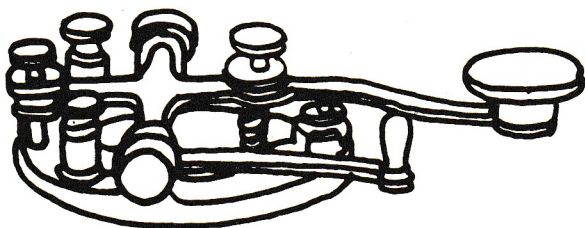
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## FROM THE MORSE KEY TO THE AGE OF COMPUTERS : THE AMATEUR WAY

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".... This is Victor Uniform 2 Delta Alpha Delta, VU2DAD calling Oscar Hotel 2 Oscar Delta, OH20D. OH20D are you on the frequency? This is VU2 Delta Alpha Delta calling you and standing by. Over over."

"Victor Uniform 2 Delta Alpha Delta, this is Oscar Henry 2 Oscar Delta returning..... DAD you are 5 and 8 here..... No QR Nancy plus no QR Mexico..... good propagation DAD..... And DAD, any news from Nine Mike 2 Mike Delta, 9M2MD? Break?"

"Roger Roger. No negative. I have been trying to contact Rudy, 9M2MD, but no luck. May be he has some trouble with his equipments or his batteries going down. However it is almost the Sched time. Let us again give a call to Rudy. QSL?"

"Roger Roger. Please go ahead."

"Attention any other station listening to this frequency. This is an emergency call to 9M2MD. Nine Mike Two Mike Delta, If you hear us please repeat the word 'ROGER' several times slowly. Rudy we are extremely sorry. We have not been able to hear you in the last ten days.....

"Dah di di dit.... Dah di dah."

..... The breaker please QRX. Any other station tuning to this frequency, for your information this frequency 14.300 MHz is occupied for establishing an emergency communication network with the Bulgarian Himalayan Expedition team. If you want to join us please QRX otherwise please QSY. Now on the line are OH20D from Austria, VU2 Sierra Mike Nancy, Suhas from Bombay, VU2 Lima Kilo, Bob from Allahabad and my harmonic VU2 Hotel Sierra Yankee.

..... For the last ten days we have been trying to contact the team over the radio but without success. So any other station if you can hear Rudy, 9M2MD, please help us. Over to you Rudy, Nine Mike 2 Mike Delta..... Nine Mike 2 Mike Delta, this is Victor Uniform 2 Delta Alpha Delta standing by for your possible reply Over over."

There was a complete silence on the band so that everybody could listen to Rudy's voice.



While amateur radio operator Rudy was climbing the Himalayas as a member of the Bulgarian Himalayan expedition team, his fellow radio operators down in the plains were desperately trying to contact him over the radio, so that any possible help could be rendered in case of an emergency. Radio is the only way to keep in touch with the outside world from such exotic places. You will find it more interesting to know that such two-way wireless conversation can be monitored using your ordinary short wave radio receiver set which we will describe in the later part of this book. Listening to such wireless conversation for the first time is obviously quite a ridiculous but thrilling experience. As a newcomer you will obviously find such terms as QRX, QSY, QSL, Victor, Delta, harmonic, QR Nancy and so on a mystery. Neither these are some secret codes nor tuning to these frequencies is a threat to the privacy of some kind of secret service. These are the abbreviations and phonetics which, by international common usage, enable amateur radio operators to communicate rapidly with each other. For example, QSY is an internationally recognized abbreviation which means- 'Change your frequency' while the phonetic alphabet is useful when calling distant station or when the band is crowded, or when for any reason the station called is expected to have difficulty in copying voice signals. For example the word 'Solstice' can be spelt using phonetic alphabet as Sierra Oscar



The UN Amateur Radio Station 4U1UN : Professionals going for Amateur Radio!

Limé Sierra Tango India Charlie Echo. Using of phonetics thus helps to confirm the letters of a word rapidly without confusion.

As soon as the amateur radio operator makes his wireless transmitter on, picks up the press-to-talk (PTT) microphone or starts pounding the morse key, he sets in motion a sort of chain of communication involving a number of amateur radio stations and that is what you have exactly seen above. VU2DAD, OH2OD, 9M2MD etc. are the identification letters of amateur radio stations, more appropriately called the 'Callsign'. Just as the telephone number helps you to

find out its owner, in amateur radio the callsign helps you to identify the ham radio operator, but not in a way you do in case of a telephone. Instead of dialing a particular number, amateur or ham radio operators use hundreds of different radio frequencies. The radio operator selects a particular frequency according to his convenience and call the station with its 'callsign', also announcing his own 'callsign'. In amateur radio, by just listening to a callsign, you can tell from which part of the world the amateur radio station is operating and who is the operator. The callsign followed by the prefix VU are allotted to stations located in India. Unlike the government telephone service, there is no privacy in amateur radio service. That means when two or more amateur radio operators communicate with each others, hundreds of their fellow enthusiasts (in amateur radio jargon these enthusiasts are called Short Wave Listening Stations) can listen into the conversation. Obviously a more serious radio enthusiast will wish to join in their conversation. We hope, this book will help such enthusiasts.

To establish your own amateur radio station means you do it without any pecuniary interest. That means you are enthusiastic to join the amateur radio service as a voluntary service hobby. We assure you that lots of fun, thrill and excitement awaiting you on your way to the depth of amateur radio.

Unlike the other hobbies, amateur radio is considered as a 'service hobby' because it has immense utility to the people in general and it is the only hobby in the world which requires a govt. licence because the amateurs have to work side by side with the professionals! To utilize the expertise in amateur radio many professional organizations also prefer to establish their own amateur radio stations. One of the resolutions thus taken by the World Administrative Radio Conference, Geneva, in 1979 says that amateur radio activities throughout the world should be boosted, because-

(a) in the event of natural disaster, normal communication systems are frequently overloaded, damaged or completely disrupted;

(b) rapid establishment of communication is essential to facilitate worldwide relief actions;

(c) the amateur radio bands are well adopted for short term use in emergency cases;

(d) International Disaster Communication would be facilitated by temporary use of certain frequency bands allocated to the amateur service;

(e) under those circumstances the stations of the amateur service because of their wide-spread distribution and their demonstrated capacity in such cases, can assist in meeting essential communication needs;

(f) there exist national and regional amateur emergency networks using frequencies throughout the bands allocated to the amateur service.

(g) in the event of a natural disaster, direct communication between amateur radio stations and other stations might enable vital communications to be carried out until normal communication are restored.



## THE END OF THE SILENT AGE OF THE ETHER

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From the earliest times we humans have felt the need for communication over distances beyond the reach of our voice. Primitive people sent messages by smoke and fire signals or by thump on a drum (tom tom). Birds were trained to carry letters. These days, people do not have to light a fire or thump on a drum or ride a galloping horse or wait for a pigeon to send and receive messages. It was back in the year 1895, the air space became a precious commodity when men realized that radio frequency can be suitably employed to carry information over distant places.

The silent age of the ether came to an end with the addition of man made radio frequencies to the natural radio frequency spectrum. In just hundred years we advanced an age. Radio, with its ever-increasing benefits in every sphere of human activity, knit a new world together and opened a new era in the history of mankind. The information and knowledge exchange process is also getting revolutionized with the differentiation and diversification of human activity.

Information which is a basic ingredient of social organization and social development has considerable importance in the modern world. The information and knowledge exchange process is to be revolutionized.

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Information which is a basic ingredient of social organization and social development has tremendous importance to the modern world. You will be amazed to know that the growth of the present day electronic communication is closely associated with the experimentation carried on by amateur radio operators. Obviously they are the rare animals in our country- both in the past and at the present. While the West will give you a contrasting picture.

It was on November 2, 1920, amateur radio operator Dr. Frank Conrad went on the air with his station callsign 8XK/KDKA to announce the returns of the

Harding Cox Presidential Election in the USA and in India it was amateur operator Dr. Matcalfe, VU2KH who started public broadcasting as early as in the year 1935.

The possibility of reassembling electromagnetic wave impulses into clear speech or music became practical with Lee Dee Forest's invention of triode valve. Despite the availability of the triode valve before World War I, radio broadcasting for the most part remained the plaything of amateur radio operators. By 1923 as many as seven hundred broadcasting stations were operated by energetic ham radio operators in the USA. Etherial whispers of the radio amateurs still span the globe in search of replies from around the world and in fact they successfully communicate with each other for the sheer joy and thrill involved in it.



It was just one hundred and twenty seven years back that the news of an important happening like that of assassination of Abraham Lincoln (in 1865) took twelve days to reach Europe ! Ninety eight years

Alexander Graham Bell, inventor of the first electric speaking telephone, June 2, 1875. Bell was a student of medical science.

later, the television viewers the world over saw the funeral of John F. Keneddy as it took place. You can see the tremendous increase in the rate of private communication around the world. In 1930 only 32,000 international phone calls were made. By 1966, this number had grown to 3.5 million. The number raised to more than 100 million in the 1980s and in general technological progress go hand in hand. The fact is that we can not consider amateur radio or ham radio as something inferior or superior kind of communication system which stands as an alternative to the existing professional and commercial communication network. People of any age and any profession are found among the amateur radio operators and if we go for answering the question- 'Why they are so keen to operate a radio station of their own?' - obviously it is because of the same spirit. that haunted people like Marconi, Edison or Forest!

On both sides of the Atlantic there is a continuing debate on what the activities carried out by radio amateurs should be called. Some radio amateurs complain that the term 'ham radio' is derogatory, and some even object to being called 'amateurs' on the ground that this may be taken to imply 'amateurish', but in fact their communication system is of more than the professional standard. Alexander Graham Bell, the inventor of telephone was a medical student. As early as in 1872, an American dentist by the name of Dr. Mahlon Loomis experimented with



two flying kites each 18 miles away and each independently connected through copper wires to the ground and he successfully transmitted signal in space for the first time. Samuel F. B. Morse, who devised the now widely used telegraphic code was a painter. Nobody thought that Morse would one day invent the telegraphic code, because, though he was a science student in his school days, his effort was to become a famous painter. He indeed became a famous painter. He went to Europe to see the famous sculptures and paintings. On his way back to America, Morse met a scientist on board the ship he was travelling who showed him the function of an electromagnet. After this event wild imaginations started playing in his mind and he became so much obsessive about sending messages using electric current that finally he devised the telegraphic code and patented it in the year 1837 after a delay of five years due to red-tapism. The allocation of the Morse codes to the characters has been done in a haphazard manner. Even the coding of basic characters as the alphabet is said to be irrational. The computer scientists nowadays believe that Samuel Morse did not visualise his code as a binary sequence. They also believe that Morse had not heard of his now celebrated compatriot George Boole (1854) and his famous work on the binary algebra going by his name! Guglielmo Marconi, whom we now call 'The Father of radio' was a drop out student. He was denied a seat in the Bologna University and had to carry on his experiments in wireless independently with the moral support from his mother. She understood that he must have some sort of a laboratory, despite his father's disapproval, and she let him use the attic. Here from childhood, he assembled, tested, rejected or improved vast quantities of equipment. Little of it, as Marconi was the first to admit, was entirely original! The genius of Marconi lies in putting the developments of various scientists together to make a workable communication system. Marconi used Prof. Righi's version of the Herztian Oscillator for the transmitter. For a receiver he used Edward Branly's Wireless Detector Coherer and for the antenna he used a modified version of dentist Dr. Loomis' flying kite aerial.

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## THE OLD DISPUTE UP THERE IN THALASSA!

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**W**hen Earth's sun went nova, the MAGELLAN barely escaped in time, with its precious cargo of one million sleepers and gene banks of plants and animals. Five hundred years into the voyage they were going to stop for repairs on the idyllic planet of Thalassa.

"And now a distant thunder was rolling down from the edge of space. It was a sound that Thalassa had not heard for seven hundred years but which any child would recognize at once.

Despite the warmth of the evening, Mirissa shivered and her hand found Brant's. Though his fingers closed about hers, he scarcely seemed notice; he was still staring at the riven sky.

Even Kumar was subdued, yet he was the first to speak.

'One of the colonies must have found us'.

Brant shook his head slowly but without much conviction.

'Why should they bother? They must have the old maps- they'll know that Thalassa is almost all ocean. It wouldn't make you sense to come here'.

'Scientific curiosity? -Mirissa suggested. 'To see what's happened to us? I always said we should repair the communication link'.

This was an old dispute, which revived every few decades. One day, most people agreed, Thalassa really should rebuild the big dish on East Island, destroyed when Krakan erupted four hundred years ago....." (Excerpt from the science fiction 'The Songs of Distant Earth's by Arthur C. Clarke. Clarke is best known all over the world for his science fiction writing. Its unusual quality rests on the fact- which only slightly less known- that he invented the communications satellite in a scientific paper published in 1945. Settled in Sri Lanka in 1960, he runs underwater safaris, indulging his great love of diving. Clarke learnt a veneration for animals. Today there are a number of animal graves in his garden in Sri Lanka, and he keeps a beautiful monkey, whose demands for attention are an excuse not to write! 'The Nine Billion Names of God?' Written in 1952 is acknowledged as a literary tour de force, embracing theology, philosophy and computer science. He has his own brand of visionary romanticism and engineering horse-sense in his writings. The geosynchronous orbits of satellites are formally named as 'Clarke orbit' after his name.)

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## DOWN HERE ON EARTH

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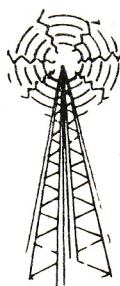
**D**own here on Earth the quest for extraterrestrial radio message already began despite the existing dispute. NASA has recently beamed it's antenna towards Pioneer-10 now into the voyage beyond our solar system and successfully received QRP (Just 1 Watt) radio signals coming from this satellite. The scientists are also very much hopeful about receiving radio message transmitted from some alien civilization, because the radio equipments and antenna they are going to put into work in the near future will be 150 times more sensitive than that are presently being used. The example of the human endeavour we quoted above is to neutralize a very reasonable question like -'What is the use of establishing a radio station which will yield no pecuniary gain and after all you are not going to talk to an extraterrestrial ?'

Yes, you are not going to talk to an extraterrestrial! But the greatest thrill in amateur radio lies in its uncertainty. Is the equipment you have constructed working OK? What is the wrong with your antenna? Will you be able to make a radio contact with your Astronomer friend in the Hawaii Island today? How far will your radio signal be travelling today? Who will be the person to answer your call at the other end of the world? Very few reasonable persons will find any sense in such kind of questions! Obviously, being an unreasonable one, you always persists in trying to adapt the world to yourself and we assure you that amateur radio is one of the right choices you should go for !



Amateur radio operators also call themselves ham radio operators forming a global community with great enthusiasm towards the field of communication technology. The political and geographical boundary of different countries never stand as barriers to their communication and infact ham radio operators play an important role in spreading the message of international brotherhood among the working people. The origin of the word 'HAM' is not confirmed, but believed that it stands for three great radio experimenters-Hertz, Armstrong and Marconi. While others have their own version; according to them during the earlier days of radio communication, government stepped in to conquer short-waves and allowed the radio amateurs to operate only on certain frequencies; thus the frequencies of amateur radio stations were sandwiched like a 'ham sandwich' and so amateur radio operator came to be called a 'ham'.

Very often we find that the newcomers confuse 'amateur radio' or 'ham radio' with 'short wave listening' or 'DXing'. When radio enthusiasts tune their radio sets in search of distant unknown radio stations, this act of listening to distant unknown station is termed as DXing (D stands for Distant, X for unknown and 'ing' for listening). Since the early days of international broadcasting on short-wave, listeners have sent in reports on reception to radio stations. In the beginning, when many of the braodcasts were experimental, radio stations relied heavily on reception reports



Tune in everyday to  
**VOICE OF REVOLUTIONARY ETHIOPIA**  
on:

31mb SW (9560 KHz)  
41mb SW (7165 KHz)  
300 meters MW

201111 654  
ADDIS ABABA, ETHIOPIA

**VOICE OF REVOLUTIONARY ETHIOPIA**

Dear Mr. Das,

*This QSL card confirms that you  
were listening to Voice of Revolutionary  
Ethiopia on:*

DATE 25-12-85 from 1505 to 1545 GMT  
Mb KHz 9560

*Thank you for your interest.*

AUDIENCE RELATIONS DEPT.

QSL card sent by a clandestine broadcasting station  
(Courtesy: Alakesh Das, Guwahati)

from their listeners. The radio station acknowledges the listener's report with a verification card, called a QSL card, because from such reception reports the broadcast operators can get a fair idea about how strong their signals are at the other end of the world. While it is the short-wave listeners credit to collect QSL card from much unknown stations operating with low power equipments. Those from distant and hard to get places are the rarer QSL card, and may achieve an almost 'philatelic' value in his area. Some more enthusiastic short-wave listeners use to collect QSL cards from amateur radio stations also. Amateur radio or ham radio is on-the air two-way communication system in which the radio enthusiast puts his own radio signals into air and try to send it as far as possible. They chat with fellow amateur radio operators, exchange ideas and information on-the -air and thus it is more thrilling than just listening to a station. Amateur radio station operators also exchange QSL card among themselves, because these cards remain as a proof that the operator was able to make a radio contact with another station located thousands of kilometres away.

Facsimile of two QSL cards sent to a short wave listener are shown below. The speciality of one of the QSL cards is that, though it was sent from a short-wave broadcast station, the broadcast station was a clandestine (unauthorised) one, operated by a rebel communist group in Ethiopia. Obviously such QSL cards are the rarer and considered more valuable than a QSL card sent from a much stronger station like that of the Voice of America! The other



TO RADIO: ALAKESH.

RSA  
ZONE 38

# ZS6AAS

| YYMMDD   | UTC  | RST | MHz    | TRX   | LINEAR  | WATTS | MODE                                    |
|----------|------|-----|--------|-------|---------|-------|-----------------------------------------|
| 88.02.06 | 1758 |     | 14.212 | 10125 | FL21002 | 100   | SSB <input checked="" type="checkbox"/> |
|          |      |     |        |       |         |       | CW <input type="checkbox"/>             |
|          |      |     |        |       |         |       | FM <input type="checkbox"/>             |

| ANTENNA                                  |                                 |
|------------------------------------------|---------------------------------|
| QUAD <input checked="" type="checkbox"/> | INV. V <input type="checkbox"/> |
| BEAM <input type="checkbox"/>            | LW <input type="checkbox"/>     |
| VERT <input type="checkbox"/>            | DIPOLE <input type="checkbox"/> |

QTH: 30° 01' 15" E 23° 51' 20" S

TNX QSL. ~~PSE QSL~~  
DIRECT/ ~~VIA BUREAU~~  
BEST 73's THEUNS

Tnx for SWL rpt.  
Much appreciated.  
Theuns.

Boulevard Drunkers

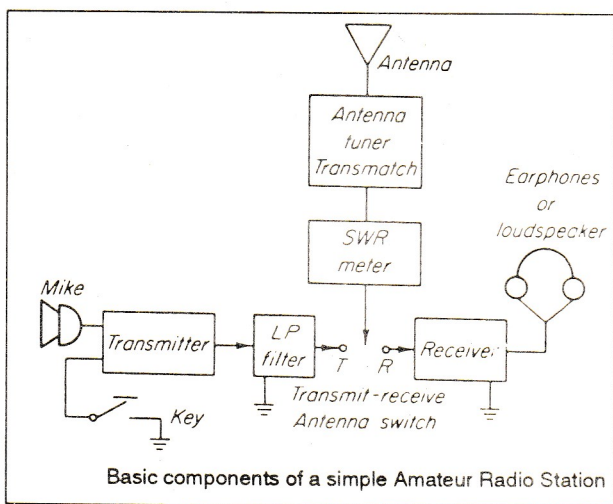
QSL card sent to a SWL from an authorised Amateur Radio Station from South Africa



QSL card was sent from an authorized amateur radio station located in South Africa.

## THE AMATEUR RADIO CALLSIGN AND AUTHORIZATION

Millions of radio enthusiasts all over the world are enjoying the thrill of contacting and making friendship with unknown persons located at distant places by radio link. They are the hobby operators with their short-wave communication rig (the communication rig is a combined unit of wireless transmitter and receiver. It also consists of an antenna, an antenna tuner and a Standing Wave Ratio meter; you will learn more about the functioning of these separate units when you go into a basic electronic course). Though amateur radio is a hobby, it requires an authorization from the appropriate authority. That means nobody is allowed to operate a radio station without a government licence. In India, the Wireless Planning and Co-ordination



(WPC) wing of the Ministry of Communications can award the radio enthusiast with a 'Callsign' and a 'licence' if they are satisfied by examination that the radio enthusiast possesses the requisite technical qualifications as prescribed under the Indian Wireless Telegraph (Amateur Service) Rules, 1978.

The Marine Radio Officers also possess similar licence, but their licence is meant for commercial purpose. There are many technical institutes which offer coaching for the Marine Radio Officer's course. To get an amateur licence is however not a difficult job. Any person above 12 years of age can prepare himself for the Amateur Radio Station Licence examination conducted by the Ministry of Communications within a span of four to six months time.

The amateur radio station callsign consists of a two or three letter 'prefix' (which essentially consists of a single or double digit number) followed by a 'suffix' consisting of one, two or three letters. The prefix indicates the country or radio zone to which the amateur radio operator belongs. For example the prefix ZS6



"Differences in skill and knowledge will continue to exist. Such differences are compatible with a free and egalitarian society. People may also want to develop their abilities in their own way. Much of the work that is done by specialists can be learned in a relatively short time so that it could be done by nearly everyone. One problem with specialists in our society is that they restrain the the number of people who are trained. We want co-operation between specialist and 'client', not solidarity among specialists.

To ensure this there could be no positions of privilege for specialists, and they must be committed to sharing their knowledge with everyone.

Expertise and non-hierarchy can co-exist only if specialisation does not convey special privileges; only if people who are experts do not monopolize or control resources or information; and only if people are committed to co-operative and collective work rather than destructive competition."

☐ **'ETHERIAL WHISPER GROUP' BELIEVES IN THE SPONTANEOUS HOMOGENEITY & NATURAL SOLIDARITY OF THE MANKIND.**

☐ **WE ARE AGAINST ALL KINDS OF ELITISM.**



Sandeep Baruah is one of the few active hams operating in the North East. Radio is his passion; by profession he is an Agricultural Graduate. His Amateur Radio station Callsign is VU2MSY.



is in the kilowatt range. (3) In SSB transmission, frequency spectrum required for a tone or voice modulated transmission is halved allowing more and more amateur radio stations to come on the band at the same time.

Despite the shortage or non-availability of Amateur Radio equipments, Indian ham operators do not feel like being handicapped, because popular low cost indigenously designed equipments and their circuits are available.

While in South India the VU2VWN 7 MHz transmitter kit is popular, in North India NR-60 model is popular as well. VU2ATNQR 20 METRE. Rig is another kit designed by Mr. Atanu Dasgupta, VU2ATN. The Printed Circuit Board (PCB) can be obtained from Electronics For You Enterprises, New Delhi.

## **MODIFY YOUR ORDINARY RECEIVER TO RECEIVE SSB AND CW TRANSMISSION**

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**A**s we have already mentioned that our home radio sets are meant to receive AM signals only and not to receive SSB signals; a separate unit is required at the 'Detector' stage of the AM receiver, which is nothing but a 'stable radio frequency generator/oscillator', called the Beat-Frequency-Oscillator-BFO, that introduces a 'local carrier frequency', frequency of the carrier being 10 to 20 Hertz within that of the transmitter carrier frequency which is suppressed at the transmitter of the amateur station willingly in order to save power.

You can exploit the local oscillator of a 2 band AM pocket radio to provide the necessary injection voltage to the main home radio set tuned to 20 m or 14 MHz ham band. Just tune the pocket radio to heterodyne with the ham band frequency by keeping it near the main radio, the process of inductive coupling being used which does not require any internal circuit modification of your radio and the 'Voice' as well as 'Morse code' CW-Continuous Wave coming in the SSB mode become intelligible.

So first you have to locate the SSB transmission from the amateur radio station over you radio; once receiver is in zero-beat (same frequency) with the SSB transmitter frequency, you will hear the SSB voice transmissions like 'Duck quacking'. Without a BFO it is quite impossible for you to find out what is going on. To make the SSB transmission intelligible, you place the pocket radio near the main radio which you have already tuned to the SSB transmission and by trial and error method tune the pocket set near to the main receiver frequency by keeping its volume at minimum until the SSB transmissions of the main radio become intelligible.

In the April 1985 issue of Electronics For You (page 71) another method of receiving SSB transmission was described by G. Gururaj, VU2GRU. The BFO unit described there can be obtained by VPP in assembled form of MITSUI Pocket Signal generator(BFO) BFO cum frequency Marker at the cost of Rs.61/-

from 'Kits 'n' Spares, 303 Dohil Chambers. 46 Nehru Place, New Delhi 110019. Phone 6430523. Please enquire its availability before placing the order.

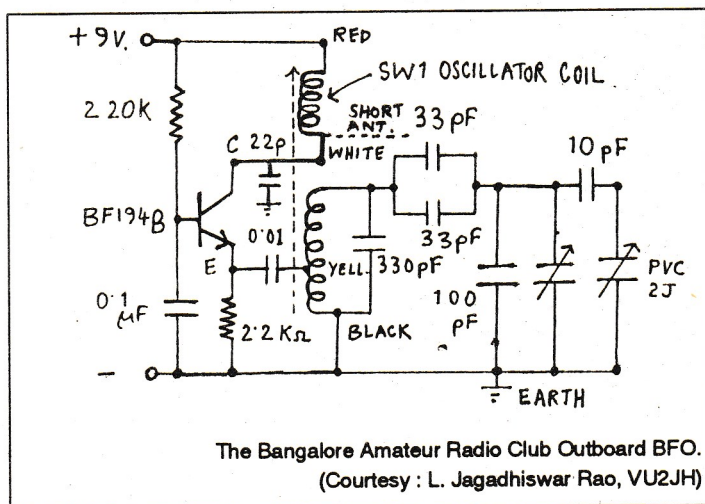
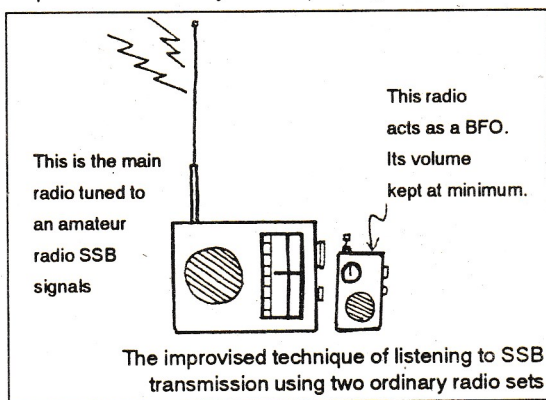
The project group of Bangalore Amateur Radio Club developed another Out-Board Beat Frequency Oscillator (BFO). If you want to go for a homebrewing, then try the BFO circuit developed by L. Jagadhiswar Rao, VU2JH of BARC given below.

Solving the problem of receiving SSB

amateur stations, the next step may be sending a Reception report to the amateur station and getting a QSL verification card in return from him.

You will find the name and addresses of Indian amateur radio stations in the 'Directory of Amateur Radio Stations' known as the 'Indian Callbook'. The latest 'Indian Callbook' can be obtained from the Director, National Institute of Amateur Radio (NIAR), Raj Bhavan Road, Somajiguda, Hyderabad-500482 at the cost of Rs. 46/- in terms of draft in favour of the Director, NIAR.

Federation of Amateur Radio Societies of India (FARSI) also publishes a 'Callbook'. Their address is : FARSI, C/O. Pillar Induction Pvt. Ltd., Block A-13, 2nd Avenue, Annanagar. Madras-600 102





## ANTENNA : THE MOUTH AND EAR OF YOUR RADIO

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The radio amateurs use low power transmitters (as compared to broadcasting stations) for worldwide communication; You will find Indian Amateur stations operating with a maximum power of 150 watts and 400 watts, only in rare cases, while from some countries amateur radio stations are allowed to pump out power as high as 1,000 Watts (1Kw). Very low power (as low as 1 watt ! -called QRP) is also heard on the amateur band.

The ordinary domestic radio set usually works without an outdoor aerial so far as broadcastband stations are concerned. But while considering the amateur radio reception with the same receiver, the situation is different;

"Antenna is, so to speak, the mouth and ear of radio (wireless) stations, by which it hears the etherial whispers coming from other station" (as told by Prof. A.D. Oliver, Queen Mary College, University of London in the International Conference on Antennae and Propagation, ICAP87). A low power transmitter with an efficient antennae system or a less sensitive receiver with efficient antennae system can be made to work beyond your imagination !

Please refer to questions and answer section of this book, where we give you a brief idea on some widely used antennae by radio amateurs.

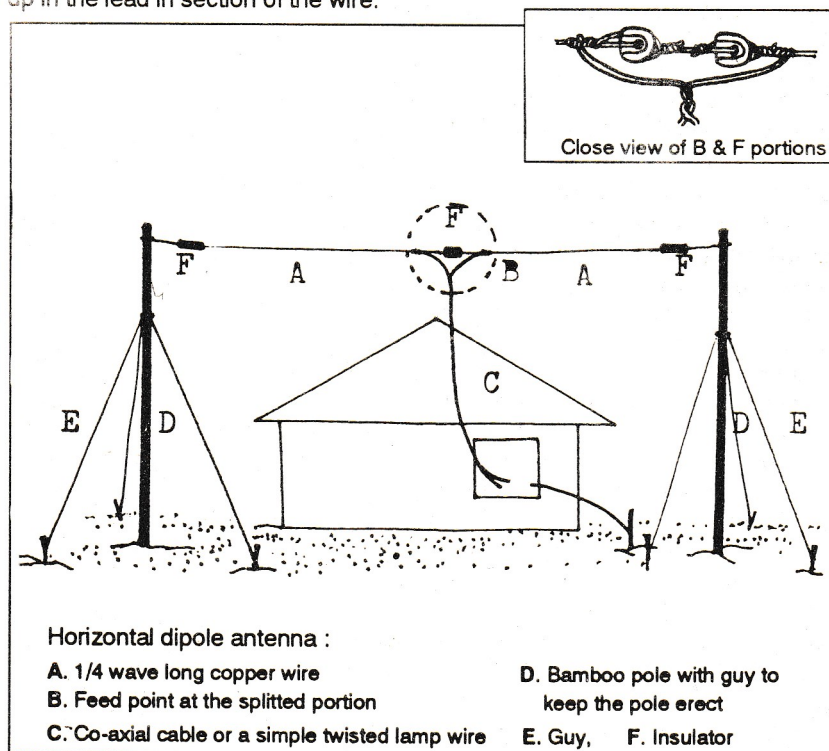
The different antennae used by radio amateurs are the dipole (either splitted or unsplitted), cubical quad, inverted-V (dipole), yagi antennae, ominidirectional ground plan vertical antennae (The antenna you see on the roof of a car is called a ground plan antenna). The most commonly used TV antennae are Yagi antennae. For amateur radio operation, the size of the Yagi antenna become very large. For the 20m amateur band (14 MHz) you have to use an yagi antenna, length of the driven element (the example of a driven element is the element in your TV antenna from where the feeder wire from the TV receiver is connected) of which is about 10 metres! Despite their large size, radio amateurs do use such an antenna because of its signal gaining quality and beaming property. The first and most effective answer to the question "How to get most from your radio" is to put up an outdoor aerial. If you have not yet tried this, you will not believe how much improvement this brings until you do try it.

At the risk of sounding too simple, the job of an aerial is to pick up the radio waves, which are electromagnatic waves speeding across the sky-and to feed them into your radio receiver. Therefore to be effective, remember that, (a) the aerial should not be placed behind any obstruction in the direction of the transmitting station. The term "obstruction" refers to any conducting material such as metal (eg. tin-roof), ferro-concrete, and to lesser extent foliage when wet; (b) the arial should be as high as practical above the ground and / or grounded (earthed) objects such as metal roofs, power or telephone wires etc.

## THE SIMPLE DIPOLE ANTENNA

It is a slightly more advance antenna. It is much more sharply directional-and is practically "deaf to stations in the direction of either end". This can be a great help in reducing interference from strong station which are located in different direction from the desired one.

Basically, the dipole must be cut to match the frequency, or at least the meter band in which you are interested in a number of different wavebands, it will probably be best to cut it to match the lowest frequency (longest wavelength) if you have enough room. The total length of the dipole should measure half the wavelength of the band selected. The aerial is divided in the centre by a glass or porcelain insulators, and the lead in, consisting of twisted insulated wire is soldered to either side. Ordinary twisted electric light flex is quite adequate for this lead in. The twist is quite important - it helps cancel out any noise (ignition noise, interference from D.C. motors or other spark producing devices) picked up in the lead in section of the wire.



The angle of pick up of the dipole is quite wide-reception is not limited to stations at exactly a right angle from either side of it. Fall-off in sensitivity is quite



in the callsign ZS6AAS indicates that the amateur radio station is located in South Africa. A list of prefix assigned to different countries are given at the end. The prefix is of immense use to the radio amateur or short wave listener, because when he listen to a particular station, he can immediately get a fair idea about how far away the station is located.

## **AMATUER RADIO-AN EXCITING CAREER AND A NOBLE SERVICE TO MANKIND**

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Once the radio enthusiast is awarded with a callsign, a wide world is opened to him. He can carry on experiments with various communication equipments and systems going deeper into the science of electronics (learning by doing) and at the same time provide great service to the people in general worldwide by way of organizing on-the-air emergency medical traffic, establishing emergency communication network during natural calamities like-flood, cyclon, storm, earthquake or any other disaster. Amateur radio stations act as the 'SECOND LINE' of communication when the existing public or government communication link fails to act. For example, life-saving facet of amateur radio was demonstrated in India with valuable public service activities during a Post & Telegraph strike in 1960, when radio amateurs passed important messages for the public. In September 1979, during the Morvi floods in Gujarat, more than a dozen amateur radio stations of western India activated emergency radio stations to pro-relief agencies, government officials and victims of the disaster. After Morvi it is convinced that this specialised technical sport or hobby is a national asset like the Red Cross. Amateur radio stations also come into action during the major sports event like the ASIAD, the Himalayan Car Rally to assist the sports officials as well as rally operators.

## **EXPLORING THE WORLD WITH AMATEUR RADIO EQUIPMENT**

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Extraordinary explorer and naturalist Thor Heyerdahl in the year 1947 during his famous 'Kon-Tiki' voyage through the Pacific Ocean used amateur radio equipments to communicate from his small raft on the high sea. Throughout the voyage, Thor along with the five member crew collected meteorological and oceanographic data and sent them to the USA via ham radio stations scattered around the globe. In fact the crew kept in touch with the outside world through ham radio stations only. It was the sole sign of their being present in the modern world. Even nowadays when the professional communication system is getting hundred percent reliable, navigators are found to use amateur radio equipments, because amateur radio has its own advantages too. There exists an International

Maritime Amateur Radio Network which provides the amateur radio operator travelling on the high sea with necessary information and weather data.

The Indian Naval Sailing Vessel 'Samudra' added another chapter to Naval Maritime history when it touched the shores of Gulf a year back. INSV-Samudra, the 13 metre long and 17 year old fibre glass yacht started its expedition on September 21, 1991 from Cochin and sailed upto Muscat (Oman) and Abbas (Iran). The speciality of the expedition was that all the seven crew members were amateur radio operators and the yacht was skippered by S. B. Anand (Callsign : VU2SBA). They were in touch with their families and their HQ via ham radio.

## PHANTOM CHATS WITH HAM RADIO OPERATORS!



A radio message can be tied to the telephone line when the existing long distance telephone network is out of order : Phantom knows it !

Artists and writers are quite aware about the potentiality of amateur radio or ham radio. We can see the innovative ideas of the creator of famous comic strip hero 'Phantom' in his comic books. In one of the comic strips, Lee Falk shows how Phantom operates his radio station from deep inside the jungle and asks his fellow ham radio operators to do him a favour by tying his short-wave radio signal into a telephone line so that he can talk to his heart-throb!



## HAM RADIO OPERATION DURING 1983-84 INDIAN ANTARCTIC EXPEDITION

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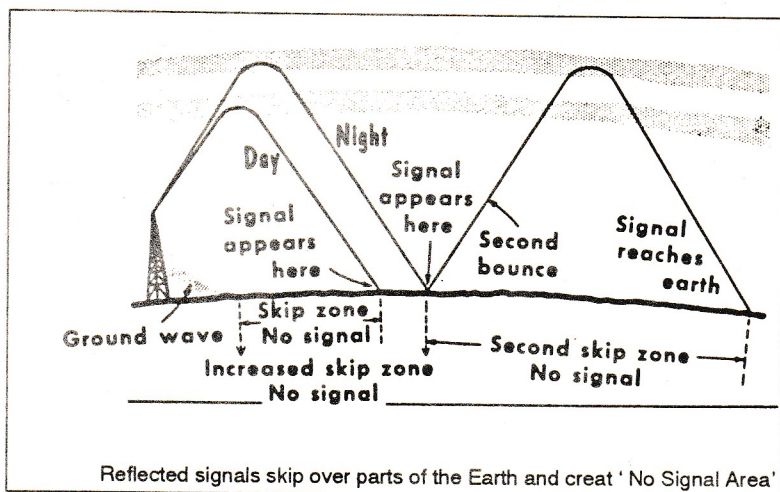
During the third Indian expedition (1983-84) to Antarctica the Indian amateur radio station VU2IF/ Maritime Mobile-3 became operational from the expedition ship "Finnpolaris" on 4th december, 1983. The station was operated by radio amateur Dr. Ashutosh Singh, the father figure of Delhi hams and an active worker of Amateur Radio Association, New Delhi. His station VU2IF was active from the Antarctic base camp with a callsign ATφA (callsign prefix of different countries are different; you will get a different callsign from the authority of a particular country when you cross the border of your native country) which regularly checked in the on-the-air Indian and International emergency and DX nets and once relayed medical traffic from Malayasia to India from its base camp. Many QSP (in the language of amateur radio, QSP refers to any kind of message which is passed on to its destination without any charge) between the members of the scientific expedition and their families in India were exchanged via amateur radio stations and several direct QSO (QSO refers to on-the-air conversation between two persons) were arranged. The amateur station showed its utility when one day the ship's SATCOM (Satellite Communication System) was out of order; a ham located in Washington D. C. relayed QSP from the Indian antarctic amateur station to New Delhi.

### WHY RELAY OF MESSAGE IS NECESSARY?

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You have seen above that a ham located in Washington D.C. relayed QSP (a message without charge send to the third party via another ham station) from the Indian Antarctic Amateur radio station to New Delhi, that means The Indian station was unable to contact New Delhi but it could contact the ham located in Washington.

While the American ham could contact both the Antarctic station and the New Delhi based station. So he could pass on the message received from Antarctica to New Delhi. to explain why it is sometimes necessary we should have an idea about the propagation of radio waves. During the earlier days of radio communication, various theories had been put forward to explain why wireless waves could be propagated over long distances. later on Oliver Heaviside in England and A. E. Kennelly in America, suggested that there must be some kind of reflecting medium in the upper atmosphere that caused the waves to be returned to earth at considerable distances from the transmitter. This meant that except for very short distances, the waves did not follow the natural curvature of the earth as had been supposed. Even Marconi himself was at a loss to explain why his signals had travelled such long distances.



Now it is a confirmed fact that under the action of solar radiation and the hail of meteorites an ionized layer is formed in the upper part of the Earth's atmosphere. In this layer the neutral air molecules are decomposed into ions and electrons and the whole layer presents a chaos of charged particles. Short wave radio signals are reflected from this layer just as light rays are reflected from the surface of a mirror, or sound from a barrier. Likewise this layer can be compared with the edge of a billiard-table. And indeed communication specialists use this layer like the edge of a billiard-table : If the ball does not go straight into the pocket, it can be ricochettted.

In the same way the short-wave signals radiated by distant radio stations get to your receiver on the rebound. What is more they can ricochet several times, for the Earth is also like the edge of a billiard-table.

If we take a simple case, a radio receiver set located at a distance of 200 kilometres away from the wireless transmitting station can not receive signals from the transmitting station, because the ground waves are stopped by the Earth's curvature (or the horizon). And the sky wave will not reach the receiver, because it bounces down again more than 200 kilometres away. So some 'Blind Zones' are formed and if unluckilly the receiver is located in that blind zone it will receive no signal or very weak signal. In such a situation, another station can relay the message to the target station.

## LIFE-SAVING FACET OF AMATEUR RADIO:REAL LIFE ACTION

The small box in the major editions of Indian Express (Feb. 11,1978) could have scarcely conveyed the impact how ham radio saved the life of a young boy. It all began on 4th February, 1978, when Dr. Kuriakos, assistant professor in Dentistry at Kottayam Medical College Hospital, who is a ham with the callsign



VU2VKK, got the information from Mr. Guhan, VU2TG about the plight of a 6 year-old Edwin lying critically sick in great need of a life-saving drug which was not available in India. The boy's father, Mr. Jebby was a Short Wave Listener (SWL) who knew about ham radio, VU2TG being one of his friends. VU2VKK immediately checked into the "Seanet" frequency and told the net controller at that moment, Mr. Stan, VS6FE from Hongkong about the plight. VS6FE on picking up the story from VU2VKK tried to locate the life-saving drug in his home town Hongkong, but no luck. The next to try was Ron, 5Z4RG in Kenya, Africa, while the air net was holding its breath. Ron tried a number of drugstores again no luck. About this time engineer Mr. Gopal, VU2GO from Dandeli joined the net and tried many amateur stations across the continents until he heard Bill, VU2AIK From Delhi, who was in contact with SV1KW (Greece) and G3FHJ (England). So he broke in with the news about the urgent need to get the drug from wherever on earth it was available. It was Sunday and both Yannes, SV1KW and Norman, G3FHJ failed in their attempt. Finally on Monday, Bill passed on the news to VU2GO that I7RQP from Italy would be rushing the drug. However VU2GO went on and scanned the 15 metre band when he heard Dov, 4Z4DK at Tel Aviv, Isreal, calling with a colossal signal. Dov got the story from Gopal and asked him to 'standby' while he made contact with



Engineer Gopal, VU2GO  
who took part in the real life action

the Italian I1NVT, Victor and told him the story. Dov, 4Z4DK then swung his mighty beam antenna back to India, while the Italian, Victor went onto the local Italian 2 metre Very High Frequency (We will discuss more about VHF in the later part of this book) net. Now returning to the high frequency band, Victor, I1NVT gave the good news that 50 ampules of the drug were available from his side. Victor drove to Milan with the drug to catch the next Air India flight. Air India carried it with utmost care and free of charge. The 40 metre (7MHz) Kerala amateur radio net was then hot with the news about the drug's arrival at Bombay. It was air lifted to Cochin and rushed by road to Kottayam.

So from Kottayam to Hongkong, to Kenya, to New Delhi from Dandeli, to Greece and England, to Italy, to Isreal and back through Italy, radio amateurs went on line to save the life of the young boy Edwin, who is now growing to be a healthy man.

In an another dramatic event British amateur radio operator Ken Kirk Bayley played a major role in saving dozens of lives in Africa. A ham radio operator at a tiny primitive hospital in the African bush sent out a SOS message. Thousands of miles away British ham Ken picked up the message that the hospital in Rwanda in Central Africa desperately needed a tiny sterilization equipment.

Within hours another ham who was an American engineer picked up the story and manufactured the component from detailed instructions broadcast by Ken. The equipment was immediately air lifted to Rwanda saving a dozen of lives.

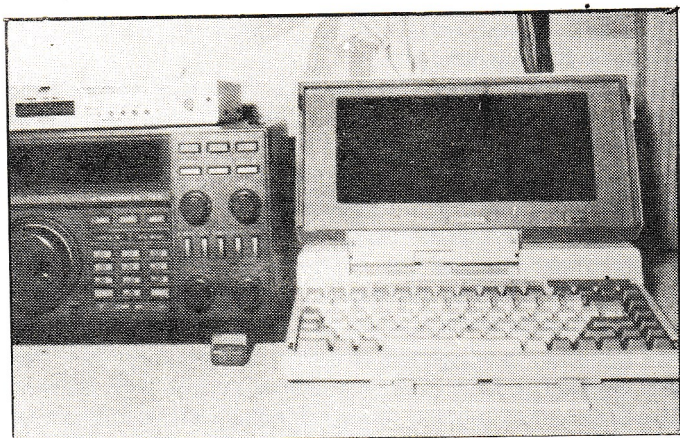
## THE EXPERTISE IN HAM RADIO

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Those events we have described are some of the remarkable ham radio events, while the present day amateur radio communication system is getting sophisticated with the growing interest in Amateur Television (ATV), involving transmission of Slow Scan Television images (SSTV); automatic machine telegraphy called-RadioTeletype (RTTY) which is a kind of computer to computer communication.

In RTTY communication, the ham radio operator enters the message to be transmitted into a computer by pounding the computer keyboard. From the computer the message goes to the wireless transmitter and other ham operators can receive the message using similar devices on a computer screen. The frequencies used in the transmission of SSTV pictures fall in the short-wave range. That means when you tune your ordinary radio receiver to receive voice signals you also tune to picture signals transmitted over the short-wave ham bands !

Today, with most traffic sent by machine telegraphy or data communication, it is observed that there are fewer professional stations availing these facilities

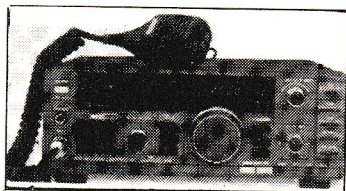


A Radio Teletype machine by the side of a transceiver set : A quicker way of dealing with written message is to make use of machines that generate a coded train of impulses, different for each letter of the alphabet, at the transmitting end, and a similar machine with reversed action at the other. This method, employing machines similar to typewriters is called radio teletype.



and Morse code heard on the amateur bands is of more than the professional standard (You will learn about Morse code in details in the later part of the book). Even before the introduction of machine telegraphy, Ted R. McElroy of the US, on July 2, 1939, in a radio tournament at Asheville, NC received Morse code at the speed of 75.2 words per minute, that is, over 17 symbols per second ! The highest speed recorded for hand key transmitting is 475 symbols per minute by Harry A. Turner of the US Army Signal Corps at Camp Crowder on November 8, 1942.

The term 'ham radio' is said to be related with the transmission quality of Morse Code by some people. Though we have mentioned that the origin of the term 'ham radio' as applied the hobby are lost in time, still some speculate that when the young and inexperienced radio enthusiasts began to venture on air with crude spark transmitters based on vehicle ignition coils, their Morse code transmission must have been pretty poor and professionals dismissed them as 'ham fisted'!



A HAM radio set

Nowadays, both in the west and the far-east, amateur radio is emerging as one of the most sophisticated electronic industries. In Japan and the USA, amateur radio communication equipments are produced in bulk which are also exported to all parts of the world. The affluent ham radio operators can go for importing such modern amateur equipments.

Amateur radio operators have been successfully putting into orbit their own ham satellites. These satellites are named as AMSAT-OSCAR (Orbiting Satellite Carrying Amateur Radio) and the Russian Radio Sport Series (-RS series).

On the occasion of the 50th anniversary of the Union of Swiss Radio Amateurs, Switzerland issued a 70 fr. value commemorative stamp in 1979. This shows a Morse key and a modern communications satellite symbolising rapid technical progress and the hams' presence in space with their own Orbital Satellite Carrying amateur Radio (OSCAR). The Union of Swiss Radio Amateurs was founded on August 9, 1929.

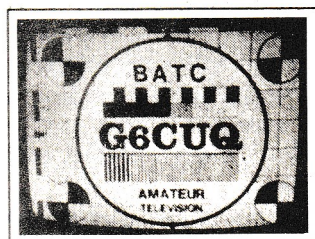
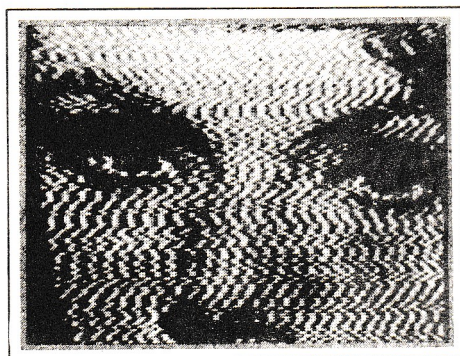
## AMATEUR RADIO OPERATION FROM SPACE

During one of the American Space missions in 1983 the amateur radio station- WØORE, operated by radio amateur Dr. Tony became operational from the space 'shuttle'- "Challenger" under the "Spaceship amateur Radio Experiments (SAREX)" programme. Dr. Tony, WØORE, automated "ham in space" operation on Thursday, August 1, 1983, when the first Amateur transmission of Slow-Scan Television (SSTV) from space took place. As the

Challenger cut across the United States from the Southwest to northeast orbit, the SSTV images were received to the ground amateur radio stations; Johnson Space Centre amateur Radio Club station W5RRR at NASA, Houston successfully monitored the amateur SSTV transmission and also by other amateur radio stations around the world. On Gwent, Wales, Mr. Bryan Davies operating his amateur station GW3HW at the Blackwood District School is the first amateur station which hold a two way radio link with the space amateur station WϕORE in both "Voice" and "SSTV" modes.

It was a great day for another ham, Alan Tavor, a 40 year old Englishman operating his station 4Z4ZB from Tel Aviv, Isreal, made contact with the space amateur station on board Challenger spaceship. Tavor got the news over his telephone that Challenger would be in orbit over Israel and that astronauts were looking forward to make contact with a local radio ham. With his antenna set at 45 degrees over Tel Aviv, Tavour, 4Z4ZB established contact with the Challenger, which was then flying at the relatively low height of 350 Km above the Earth and for two minutes he maintained a radio contact with the spaceship.

Opening up his transmission with his callsign 4Z4ZB, Tavor then received



14 MHz band Slow Scan TV picture received by an amateur on a BBC -Micro (B) with the help of interface attached to the radio (BBC-Micro is widely used in the H.S. Schools in our country under the Computer Literacy and Studies in Schools Project).

the callsign of the Challenger-WϕORE operated by Dr. Tony. They had an informal chat when Tavor told that he was operating from a farm near Jerusalem, the capital city of Isreal. Tony, WϕORE from the spaceship then repeated this message to show that contact had been made and added the remark that from space, Isreal looked great. Tavor wished the astronauts a safe journey and then the contact faded.

It was a dream come true for two ham radio operators in the Maharashtra city of Pune, when while fiddling with the dials of their sets on 14 the April, 1989, they accidentally made radio contact with a Soviet cosmonaut aboard the orbital space station MIR. Keki Darbary and Vilas Rabade, a philips engineer with his station callsign VU2VPR had a three minute exchange, listened into by many fellow hams with their walkie-talkies sets, with Valery Polyakov (Callsign :



U4MIR), who identified himself as a cosmonaut-Scientist onboard spacelab MIR, a third generation one launched from Baikonour cosmdrome in Soviet Kazakhstan on February 10, 1986.

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## HAM RADIO AS NEWS MEDIA

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**H**am radio received a unique type of recognition when it became the only news sources during US Grenada invasion in 1983.

Mark Baratella, (Callsign: KA20RK/J37) a student ham radio operator, operating from his second-floor room at Saint George's Medical School became an essential link between the island and rest of the free world as a result of the Regan Administration's decision to prohibit members of the press from accompanying the Marines to Grenda.

What emerged from Mark's transmission during the invasion was not only the chronological events which began on the morning of October 25, 1983, but also a sense of urgency, ham radio expertise and finally courage inherent in a ham like Mark.

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## HAM RADIO AS A TECHNICAL SPORTS

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**A**mateur radio-the fascinating space age hobby is enjoyed by men- ordinary men, who by their dare devil enthusiasm towards the electronic communication technology not only construct their own wireless communication equipments, but also fight courageously with nature's wrath in seas, oceans and at mountain tops. While the adventurous people like the mountaineers enjoy climbing mountains, radio amateurs go their own way of expedition called the DXpedition. The amateur radio station activated during a expedition is considered as a special event station and sometimes in an amateur radio contest, a dditional score points are awarded to the ham who can contact such special station.

Radio amateurs, like adherents to most hobbies, like to have some way of measuring their achievements. Hence the interest in chasing awards. One of the most prestigious UK awards progammes is the 'ISLANDS ON THE AIR' series of awards.

International Amateur Radio Contests are organized by different amateur radio organizations all over the world. In such a contest the amaetur radio operators are allowed to come on the air with certain power limits and specified mode of operation (either SSB, CW or RTTY) and the radio operators have to contact other stations within a specified period of time. There are different score points for making contacts with different countries of the world. for example in the GARDEN CITY CONTEST (organised by Visvesvaraya Industrial and

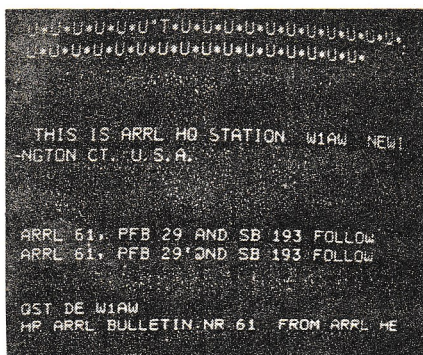
Tecnological Museum and Bangalore Amateur Radio Club, Bangalore), an Indian ham earns 1 point for each Asian Amateur radio station, 2 points for Europe, Africa and Australia and 3 points for contacting each station from North and South America. One additional score point is awarded for each QSO using home-made equipments. The time allowed is 24 hours. In some of the radio contests ham radio operators can join in groups; that means that while one operator makes a contact with another station on a particular frequency, his group operators search for other stations on other frequencies which can make the scoring process much faster.

The ability to win such radio contests also exhibits the amateur radio experimenter's ability to construct and assemble effective antennae systems, different accessories required with the transmitter and receiver and also his skill in on-the-air communication. You may see the more enthusiastic ham radio operator pounding his Morse key or computer key board and making radio contacts with hundreds of amateur radio stations around the globe, exchanging ideas, information, arranging topics of their interest, while the ham is also busy in controlling the beam antennae system positioning it to different bearings by just pressing a button on the computer keyboard !

The amateur radio operator is however a rare animal in our country, perhaps due to the lack of certain traits in the nature of our people! If a person does not find it fascinating and thrilling to work lonely hours in establishing a radio link with exotic Hawaii or Classical Greece or dynamic Japan, he will obviously find no interest in amateur radio ! If all the radio amateurs in Japan were to stand with out-stretched arms touching, this human chain would span 1,650 Kms ! That's quite a distance but more importantly that's an astounding number.

## THE MOST ASSIDUOUS RADIO HAM IN THE WORLD

Many crazy people devote some valuable parts of their life to create international records, some even give their life in doing so, and people do respect them, memorize their names! If Sunil Gavaskar makes it a world record by collecting 10,122 runs in 125 Tests, what is the immediate utility of such a remarkable job to the people in general? There will be no reasonable answer to



RTTY message copied by a Ham operator.

The ARRL HQ was going to broadcast its on-the-air bulletin.



such an unreasonable question! Amateur radio operator Richard C. Spenceley operating his station KV4AA at St. Thomas US Virgin Islands built his radio contacts to a record level of 48,000 in just 365 days in 1978 and got a place in the Guinness Book of World Records as the "Most assiduous radio ham in the world"!

But we need more and more amateur radio stations in our country to utilise the expertise in ham radio in public service activities. This hobby can play an important role in spreading the message of brotherhood among the working people.

## GETTING STARTED WITH YOUR RADIO : MY EXPERIENCE

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**Y**ou can enter into ham radio by first using your ordinary short-wave radio receiver set to receive ham radio stations. It is my opportunity to tell you about my amazing experience. I could listen to the amateur radio stations using our 10 year old two band shortwave radio and as a young radio enthusiast I found it quite thrilling to listen to the radio amateurs around the world using an ordinary radio. I do still remember the cold winter night of 11th february, 1986 when I was burning midnight oil to locate amateur radio stations over the 20 metre (14 MHz) short-wave band by turning the tuning knob up and down. To my awe and astonishment, at 1718 UTC (GMT is also known as Universal Coordinated Time. The conversion formula to get the IST is to add 5:30 hours to the UTC; so the IST becomes 22:48 hours. Please refer to the time conversion map) came the colossal signal of a Dutch ham, Robert, operating PA3BKL Maritime Mobile (The callsign of an amateur radio operator should be always followed by the words Maritime Mobile when the station is onboard a moving ship) from a cargo ship 700 miles west of Bombay on the high sea who was in contact with a Bangalore based amateur radio station VU2KYX. The exact location Robert, PA3BKL/MM gave to VU2KYX at 17:23 UTC after he looked at a display in his radio room was 17.42 degrees North and 64.08 degrees East. Robert was the Marine Radio Officer of the ship bound for Iran from Australia. He talked with VU2KYX on different interesting subjects like the use of IBM and Apple computers, the small device called 'mouse' (and which I now see my friend Alakesh using smoothly to make a layout of this book!) which Robert used to draw pictures on the computer screen, about his selfmade father whom he feels proud of, about his native country- the Netherlands and its people, about his home town Culemborg, located at the centre of the Netherlands. Robert also informed VU2KYX that their ship's Satellite communication system was out of order since January 14, 1986. As a young radio enthusiast I found it a thrilling experience to explore the short wave band in search of voices coming from such exotic places and in fact the image of a lonely man travelling on the high sea and talking to a person in a

distant land made me so obsessive that that might be one of the reasons I became a ham radio operator!

Good ham band DXers become expert amateur radio operators because of their experience gathered as short wave listeners and they know the art of on-the-air communication in advance.

It is said that to be a ham radio operator you should have some experience in listening to amateur radio stations, even if you do not that however will make little difference.

Monitoring and reporting of the standard broadcasting radio stations are possible with your home radio set, because the broadcasting stations use Amplitude Modulation (AM) mode of transmission and obviously the radio sets



A modern Japanese Communication receiver

available in the market for general public are designed only to receive these AM stations.

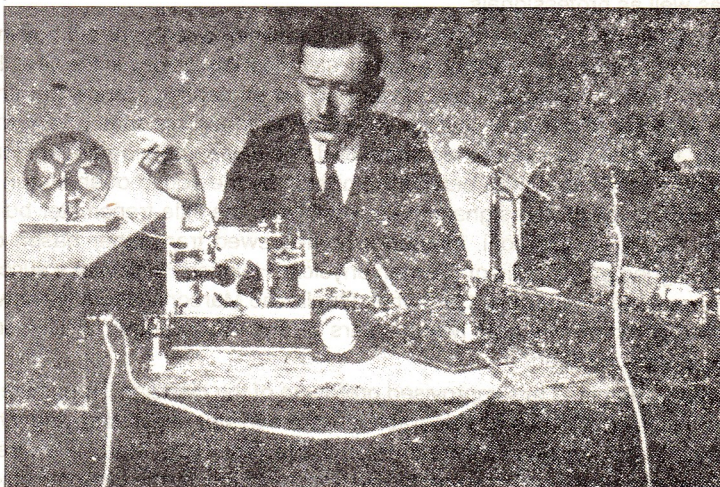
The radio amateurs use a very efficient mode of transmission called the Single-Side-Band (SSB) transmission; SSB transmission can be received on a special type of receiver called the "Communication receiver" which is of course not commercially available in India; so you have to depend on your ordinary radio modified to receive SSB stations with intelligible reproduction of the "voice" and "Morse code" transmissions.

Briefly, a SSB signal can be defined as a modulated signal without a sideband. By SSB transmission -(1) Interference between several carrier frequencies used by the stations is avoided, thus the problem of steady audio whistles or 'beats' is avoided which is a common problem faced by the short wave listeners while listening to some international broadcasting stations operating with close frequencies in the AM mode;

(2) In SSB transmission, power is saved; with a 50 watts or even less than this we can do world wide communication which is not possible with an AM transmitter with the same power rating but only possible when its power rating



year old Marconi called his mother to his laboratory and showed her his experimental apparatus, a wireless transmitter comprising accumulators, induction coil, Leyden jars and a Hertzian radio oscillator on one side of the room; and on the otherside a coherer receiver, battery, electromagnetic relay and electric bell-which together made up the receiver. Then he pressed the signalling key of his transmitter. To his mother's awe and astonishment, the bell on other side-of the room started ringing which had no wire connection with the key. When next morning, Signara Marconi proudly told her husband of their son's achievement, the inventor's father was only scathing about his son's discoveries and remarked dismissively that it seemed a round about way of working a perfectly ordinary bell a few yards' distance! Marconi the 1909 Nobel laureate in Physics; as a boy who was denied study in Itali's Naval Academy and Bologna



Marconi with his homebrewed wireless equipments. These were the equipments damaged by some govt. officials when he was proceeding to London.

University as he failed in the Entrance test, had to enroll himself in a small technical school brought revolution to the electronic communication technology.

In 1919 an adventurous Marconi bought a small ship, which he converted into a floating laboratory to conduct his experiments in wireless communication. In this ship, Marconi was conducting his experiments using short wave frequencies and Beam Antennae systems.

The experiments carried on by Marconi fascinated radio enthusiasts all over the world and hundreds of private experimental wireless communication stations became operational in America and other parts of the world. As early as 1912, many regular government and commercial wireless stations had been established. They were all on long waves of 200 meters.

## RADIO OPERATOR TURNED GEOLOGIST

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Ernest Krenkel

**E**rnest Krenkel, the author of the book "RAEM Is My Call-Sign", is a famed Soviet polar explorer. His preoccupation with the North began in 1924 when he got the job of a radio operator at the Novaya Zemlya polar station, his career spanning many years of work in the North.

Krenkel was a radio operator at polar stations and ships going on expeditions. He took part in the record-breaking voyage of the "Alexander Sibriakov" ice-breaker, which covered the entire Northern Sea Route in single navigating season. A year later Krenkel a radio operator on the "Cheliuskin", sent the now famous radiogram that the ship had perished and the crew pitched camp on the ice. In 1937 he was among the celebrated Papanin's team of four as the radio operator of the North Pole, the first drifting station.

In 1930 he established a link between the Franz-Josef Land and the Antarctic, a record in long-distance radio communication. Later Krenkel, the radio operator turned a Geologist and was in charge of the Research Institute of Hydrometeorological Instrument Making.

## RADIO OPERATOR TURNED BROADCASTING GENIUS

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**H**is mother wanted him to be a Talmudic Scholar; his father, a merchant. Instead, David Sarnoff became the most dynamic foresighted figure in the history of American broadcasting.

Two days after he arrived in the United States from Russia in 1900, nine-year old David was peddling newspapers. He never stopped working. Early jobs as a radio telegraph operator took him to the Arctic aboard ship, to a lonely station on Nantucket Island (Where he read a complete technical library), then to a wireless station at a top Wanamakers's department Store in New York.

There on April 14, 1912, he picked up a faint message: "S. S. Titanic ran into iceberg. Sinking fast". Sarnoff called newspapers and bent every effort to establish radio contact with ships near the Titanic. When President Taft ordered all other stations off the air, the 21-year-old radio operator became the nations



only link with the scene of the heart rending disaster. Slowly, the names of survivors taken aboard the rescue ship Carpathia began to trickle in. Not until the list was complete did Sarnoff abandon his post. He had been at his Morse Key for 72 hours at a stress!

Under Sarnoff's guidance, RCA founded the National Broadcasting Company in 1926 to promote the radio and its programs. A music-lover, he broadcast live opera from the stage of the Metropolitan in New York.

## THE FIRST AMATEUR RADIO ORGANISATION OF THE WORLD

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One night in March 1914, Hiram Percy Maxim, an ardent radio amateur tried in vain to contact Springfield, Mass, from his station in Hartford, Conn, some 37Kms away. His equipment could not transmit over this distance, but a station between the two points relayed his message and also relayed back a prompt reply. This incident led Maxim to conceive of an organization across the country. He and Clarence Tuska, a college student founded the American Radio (Amateur) Relay League -ARRL in May, 1914 and they started publishing an amateur radio magazine named "QST" in 1915.

## WHY THE SHORT WAVE IS USED?

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At that time it was believed that short waves -SW (It is the wavelength of a frequency calculated from the formula :  $\text{wavelength} = \text{Velocity of electromagnetic wave} / \text{frequency}$ ; or in practical, wavelength in meters =  $300 / \text{frequency in Mega Hertz, MHz}$ ) ranging from 3 to 30 MHz can not span the world, so not useful for long distance wireless communication. The Government authorities hence permitted amateur radio operators to operate their experimental wireless stations in the short wave spectrum only. The beginning of World War I even put an end to amateur radio operations and it was not until October 1, 1919, that the governments again permitted hams to transmit.

The main reason of preventing the experimental stations from invading the long wave bands of the radio frequency spectrum was to avoid overcrowding of the long wave which was used extensively by government professional and commercial stations.

But the non-professionals didn't feel like being handicaped by the prevention. Their victory came soon. Specialists were non-plussed to see that with the aid of short wave amateur stations, it was possible to set up communication with any point on earth! Little transmitters which consumed no more power than a

twenty-watts bulb sent signals farther than long-wave stations with a capacity of several thousand watts.

Hiram Percy Maxim, who was the founder of American Radio Relay League (ARRL) made radio contact between Schnell, USA and Delom, French in November 1923 using about 2.7 MHz frequency which was in the lower short wave band.

The Atalantic City Conference of the International Telecommunication Union (ITU) in 1947 subdivided the radio frequency spectrum. The different subdivisions are stated below.

Each subdivision of the radio frequency spectrum has its own propagation characteristics through the land, water and the atmospheric envelope covering the earth. For example it has been experimentally observed that VHF usually penetrates the Ionosphere and are lost into space while the HF (or Short -wave) are reflected back from the Ionosphere.

| Frequency Range | Atlantic City<br>frequency subdivision | Notes                                                    |
|-----------------|----------------------------------------|----------------------------------------------------------|
| 3-30 KHz        | VLF (Very Low Frequencies)             |                                                          |
| 30-300 KHz      | LF (Low Frequencies)                   |                                                          |
| 300-3000 KHz    | MF (Medium Frequencies)                |                                                          |
| 3000-30,000 KHz | HF (High Frequencies)                  | Above 30,000 KHz<br>frequencies are<br>indicated in MHz. |
| 30-300 MHz      | VHF (Very High Frequencies)            |                                                          |
| 300-3000 MHz    | UHF (Ultra High Frequencies)           |                                                          |
| 3000-30,000 MHz | SHF (Super High Frequencies)           | Above 30,000 MHz<br>frequencies are<br>indicated in GHz. |
| 30-300 GHz      | EHF (Extreme High Frequencies)         |                                                          |

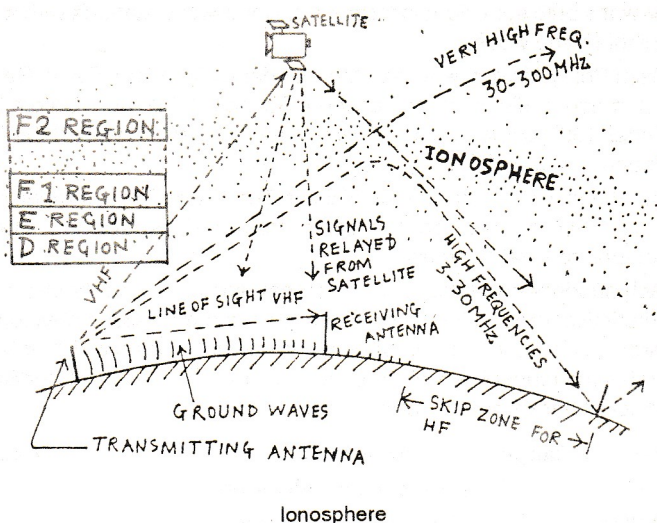
## SHORT WAVE PROPAGATION AND THE ROLE OF IONOSPHERE

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**S**hort wave or high frequency (HF) radio waves propagates in a wonderful way. It goes to an invisible layer which consists of charged particles located at altitudes of between 250 and 400 Km in the atmosphere surrounding the Earth. This layer of charged air particles called F-2 layer of the ionosphere plays a vital role in HF propagation by reflecting or refracting the HF-signals back to earth.

The Ionosphere has got different sublayers. The lowest is D-layer at altitudes ranging from 50 to 90 Km. High frequency (HF:3-30 MHz) penetrates this layer, while low frequency (LF:30-300KHz) or medium waves are absorbed by this





layer. To some extent LF and Very Low Frequency (VLF-3 to 30 KHz) are reflected during daytime. It slightly scatter and absorbs HF. This layer subsists only during daytime.

The E-layer extends from an altitude of 100 Km. Sunlight is an important factor for its existence and so exists during daylight, but after sunset also it exists for some time. This layer is responsible for evening and early night time propagation of medium waves (low frequency) upto a distance of about 250Km. Propagation of lower short wave frequencies, e.g. 2 MHz upto a distance of 2000 Km at daylight time is due to this layer. It has little effect at night.

F-1 layer exists at an altitude of 200 Km during daytime and characteristic very similar to E-layer which emerges into F-2 layer at night.

F-2 layer is the most important layer which exists at altitudes ranging from 250 to 400 Km and HF long distance propagation round the clock is due to this layer. The behaviour of this layer is influenced by the time of the day, by season and by sunspot activity.

## HOW RADIO AMATEURS SELECT SUITABLE FREQUENCIES?

It is found that when the degree of ionization is great, the higher frequencies in the HF spectrum are reflected, say frequencies like 14 MHz, 21 MHz and 28 MHz. But when the ionization is low, less reflection of higher frequencies of the short wave spectrum is the result, but the relatively lower frequencies in the short wave spectrum like 3 MHz and 7 MHz are more readily reflected. During daytime,

since the degree of ionization of F-2 layer is more than in night, you will find that amateur radio stations operate on 14 MHz or 20 m (this frequency band is ofcourse active round the clock), 21 MHz or 15m and 28 MHz or 10m band during daytime, while early in the morning and at night you will find that there are little ham operations on higher frequencies e.g. 21 MHz is very little active at night while at this time lower HF bands (e.g. 7 MHz) are more active.

Around the sunspot maximum years (1937, 1947, 1958, 1969, 1979) at about 11-year intervals, the daytime F2 layer, roughly 200-400 miles above the surface of the Earth, can often open long-distance paths of frequencies up to and beyond 50 MHz. In periods of low sunspot activity very few long-distance paths are open above 25 MHz. Radio amateurs, whose transmitters are so much less powerfull than thoes used for broadcasting, have come to recognise the importance of what is called 'grey line' propagation, particularly on the lower part of the high frequency spectrum. This takes the form of the reliable but brief long-distance paths that open between places where the times of dawn and dusk, dawn and dawn or dusk and dusk roughly coincide, giving rise to the possibility of extended 'one-hop' propagation due to layer entrapment brought about by tilts in the F-Layer, as the lower F1 and higher F2 layers combine or seperate.

As we have mentioned that 7 MHz is a favourable band for night time operation, with a low cost transmitter having power below 5 Watts, you can expect to contact stations located in Delhi or Madras from Guwahati during night time, while during day time with the same power you can contact only upto say a station located in Ranchi. My own experience with the NCSTC QRP 7 MHz Rig is quite satisfactory. With power below 5 Watts, stations from New Delhi (VU2LO, VU2YK), Madras (VU2VMZ) and one Asiatic Russian station (UAφY/UZφ) were contacted.

## THE FREQUENCY ALLOCATION TO AMATEUR STATIONS

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As you have seen during the 1920s transmissions in shorter wavelength were achieved and found to be more efficient for long distance communication. By 1924 many government and commercial wireless stations started operation on short wave, below 200 meter wavelength, which led to interference and great confusion.

Then the International Radio Conference of the International Telecommunication Union (ITU) was held in 1927 in Washington. Eighty countries were represented in the conference. In addition to frequencies allocated to different services in the 1906 Berlin Radio Conference, in which maritime services were allotted 500 and 1000 KHz (600 and 300 meters respectively), while frequencies below 180 KHz were allotted to long distance communication by coastal stations; the band between 188 and 500 KHz was allocated to military and naval stations and closed for everyone else, the



Washington Conference allotted different frequency bands to new media like broadcasting and aeronautical services. In this conference the spectrum was then fixed to range from 10 KHz to 60,000 KHz. i.e. 60 MHz and also included the Short wave range-3 to 30 MHz.

The problem of variable propagation conditions can be partially overcome by using frequency diversity (as we told above), in which an allotted communication network is provided with several frequency assignments spanning the HF band of frequencies, so that the radio operator can choose the channel that gives the best results at any given time.

The amateur radio stations are presently allotted the following bands in the radio frequency spectrum of which the 10, 18 and 24 MHz bands are the latest approved by World Administrative Radio Conference (WARC) at its International Telecommunication Union (ITU) conference in 1979.

| Frequency       | Metre band | Remark                                             |
|-----------------|------------|----------------------------------------------------|
| 1800-2000 KHz   | 160 m      | Regions 2 & 3 only<br>1810 to 1850 KHz in region 1 |
| 3500-3800 KHz   | 80 m       | In region 2 to 4000 KHz                            |
| 7000-7100 KHz   | 40 m       | In region 2 to 7300 KHz                            |
| 10100-10150 KHz | 30 m       | On secondary shared basis                          |
| 14000-14350 KHz | 20m        |                                                    |
| 18068-18168 KHz |            |                                                    |
| 21000-21450 KHz | 15m        |                                                    |
| 24890-24990 KHz | 13 m       |                                                    |
| 28000-29700 KHz | 10 m       | (Please refer to the Radio Region Map)             |

In the Very-High-Frequency (VHF) band ranging from 30 to 300 MHz, amateur radio stations are allotted 144 to 146 MHz and in the Ultra High Frequency (UHF) band, amateur radio stations are also allotted 434 to 438 MHz, 1260 to 1300 MHz, 3300 to 3400 MHz and 5725 to 5840 MHz for satellite communication.

## AMATEUR RADIO CHANNELS: DIFFICULTY FACED IN COPYING AMATEUR RADIO STATIONS OVER ORDINARY RADIO SET

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The favourable bands over which you can locate amateur stations using your ordinary radio are the 20m, 15m, 40m and 10m bands. But 20m and 15m are the most favourable bands to start with your radio. The broadcast band radio sets have the difficulty concerning bandspreading. As you turn across the dial indicator over a particular band of the dial by adjusting the tuning knob, a slight

movement in the tuning knob will take you to a higher channel discarding the channels between. Since these radio sets are not designed to provide proper -Band-Spreading, initially you will find difficulty in locating a particular amateur station. For example in the 20 meter amateur band there are a total of 350 amateur channels (14000 to 14350 KHz); in each of the channel, hundreds of amateur stations can come on the air at the same time; this is because DUPLEX Communication Technique is not followed by the radio amateurs for their own convenience, that means when one amateur station is transmitting, all others listen to him and he passes on to a particular amateur station to take the next over, ending his transmission. This technique is called SIMPLEX communication.

## **WHAT IS A DUPLEX COMMUNICATION?**

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In duplex communication, two wireless stations use two different frequencies to communicate. For example when one station transmits on 7005 KHz. the other station transmits say on 7036 KHz. For duplex communication, usually the operator should use a separate receiver to listen while he transmits. The advantage is that the possibility of overlapping can be avoided. In case of a transceiver set (the combined unit of transmitter and receiver), the operator while transmits can not listen to the other side. Only after giving the 'OVER' to the next person he can listen. It may so happen that while he transmits, the other side also transmits at the same time, the result is the waste of energy, neither person listening to each-other! This is not a major drawback in case of SIMPLEX operation. While sending a longer message, the operator can switch off his microphone for a moment to see whether any overlapping is taking place. This simplex (both stations using the same frequency to transmit) communication makes it possible to spare another frequency to other operators and thus has its own advantage. Modern transceivers have the facility for Duplex Communication by split frequency operation.

## **NATIONAL EMERGENCY TRAFFIC**

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You can listen to the Indian amateur air-net (also known as National Emergency Traffic-NET) organized each day on 14.150MHz (in the 20m band) at 19:30 hrs onwards when most of the Indian Amateur radio stations come on the band to organize any "Emergency medical Traffic" and to examine the radio wave propagation condition both within and outside the country. A Net Controller handles the band for one hour and calls the Indian Amateur Radio Stations one by one according to the Postal zone sequence. Any station who wants to make



a 'Contact' with another station informs the net controller accordingly and the net controller asks whether that particular station is listening; as he gets a 'Roger' signal from the station, he requests him to go to another channel and make a contact with the station which is in search of the later one. In an ordinary radio set it is difficult to locate or tune to each channel. Suppose the net controller tells the station to change his frequency from 14.150 to 14.155, it will be difficult for you to follow him and instead of reaching 14.155 your tuning knob may take you to 14.300 MHz! Still you can try to locate powerfull amateur radio stations on this band, while stations with low signal strength in adjacent frequencies (Channels) get suppressed.

**THE JAM NET :** This Medical Net is organised each day at 2200 hrs on 7.070 MHz by the South Indian Hams.

**THE NORTH EAST NET :** This Net is in operation since September 1986 from 07:30 to 0800 IST on 7.065 MHz despite constant interference caused by Assam Rifles stations.

**SEA-NET :** The South East Asia Net is organised each day at 1200 UTC on 14.320 MHz. The SEA-NET members organise ham radio convention in different South east Asian countries each year. The 1993 SEA-NET Convention is going to be held at Cox Bazar, Bangladesh under the initiative of Mr. Saif, S21A, the first ham in Bangladesh.

## WHY A COMMUNICATION RECEIVER REQUIRED

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**W**ith a Communication Receiver you can overcome all these problem. Communication receivers are very sensitive, selective and having good fidelity. They may follow the Double Super-Heterodyne principle for excellent reproduction of the transmitted signal and also their circuitry are designed to give a very proper Band Spreading along with a Visual Display Unit in which Digital readout of the frequency to which the receiver is tuned can be found accurately. You can go from 14.000 MHz to 14.001 much more easily which you can not hope in case of an ordinary radio. The communication receiver also possesses a Radio Frequency (RF) Gain control knob; it is meant to reduce the receiver gain when the received signal is too strong to bear by the receiver and thus distortion due to overloading is prevented, also the life span of the circuitry is enhanced. Communication receiver is provided with an inbuilt Beat frequency Oscillator (BFO) and a knob to align the BFO frequency with the incoming SSB and Continuous Wave (CW) Morse code transmissions from amateur radio station.

## **VIOLATION OF INTERNATIONAL RADIO REGULATIONS IN INDIA**

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The Atlantic City (USA) Conference of the International Telecommunication Union (ITU) in 1947 divided the world into three (3) radio regions. As per the regulation, the South East Asian countries are listed in Radio Region 3 and in this region one of the frequency bands allocated to the amateur radio stations range from 7.000 MHz to 7.100 MHz (7000 to 7100 KHz). As per the notification of the asstt. Wireless Advisor to the Govt. of India, dated 4th October 1985, and according to amended Indian Wireless Telegraph (Amateur service) Rules, 1978, the frequency spectrum 7000 to 7100 KHz remains solely for the ham radio stations on non-shared basis. No other service can share this band with the ham operators.

This band has a special importance to the radio amateurs, because the electronic components available in the market can be suitably employed to construct low cost equipments capable of operating on this band and in fact Indian hams are quite enthusiastic to operate with such low cost very low power (QRP) indigenously built rigs. Unfortunately there is a continuous violation of both international and Indian radio regulation by some quarters. It is quite painful to see that some very high power government and commercial wireless stations occupy this band all the time and do not allow radio amateurs to come on the band. They even hurl abuses on the amateur radio operators with slang languages. In the North-Eastern region under the initiative of hams based in Calcutta (Calcutta has the rich heritage of amateur radio operation since 1925 and in fact the first Indian amateur radio station was set up in Calcutta by Lokendra Bose, VU2AG under the guidance of nobel laureate Sir J. C. Bose ), specially under the initiative of Mr. D. P. De, VU2DPD, the radio amateurs lodged a complain against the unauthorized users. It is very disheartening to note that the army ( specially the Assam Rifles) people have been resorting to use the amateur band unauthorizedly, which may lagitimately called a piracy. We found to our utter dismay that the 7MHz frequency band is now a crowded band with little space left for the amateur radio operators and the unauthorized operators very often resort to intentional interference. A concerted effort is necessary to restore this frequency band to its real users and thus protect the pride and glory of our tradition.

## **HIGHER, FASTER, FURTHER : HAM POPULATION**

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The number of amateur radio stations is increasing rapidly, particularly in the industrially developed countries, or otherwise we can say that the energetic amateur radio operators are the backbone of electronics industries of the Far East or the Far West. The ham population of Japan is estimated to number more than one million, while in Germany it is more than fifty three thousand. The USA



ranks next to Japan with an estimated population of five lakhs. While the tiny island called Japan ranks first, India shows a contrasting picture. Only 5528 amateur radio stations are located in India. In the whole North East, the amateur radio population is only 28;

Most of the Indian amateur radio stations are located in the Southern states of Tamilnadu, Kerala, Andhra Pradesh and Karnataka. Garden city Bangalore, which is also considered as a BOOM CITY in the field of electronics can feel proud of having nearly a thousand ham radio station. They are very active hams. That is what their advertisement exactly says. In one of their advertisements, the Bangalore hams welcome the outsiders to their city and say that one can take part in their VHF walkie-Talkie activities or one can call them at anytime on 145.5 MHz if he requires any assistance, emergency etc.

## **PIONEERS IN ASSAM**

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The most energetic and active ham radio operators in Assam are **Mr. Ranjit Chaliha, VU2RCH** and **Mr. N. K. Baruah, VU2NKB**. Chaliha is a selfmade expert in electronic circuitry running a completely homebrewed radio station to his credit; Mr. N. K. Baruah is an energetic promoter of ham radio in Assam. It was because of his guidance many young radio enthusiasts could come on the air band. It was because of his initiative came into existence the first Amateur Radio Club of Assam at Assam Engineering College, Guwahati. This club since produced more than six hams from AEC under the initiative of Mr. Kalyanmoi Dihingia, VU3KID.

## **FIRST HAM RADIO DEMONSTRATION IN ASSAM**

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Six years back, Mr. B. M. Hegde, VU2HEG (who was The Vice-Chairman of Karnataka Regional Engineering College Amateur Radio Club) arranged an amateur radio demonstration-cum-lecture under the initiative of Mr. Deepak Sarma (who had since passed the ASOC Examination but unfortunately yet to receive his licence). The ham demonstration was attended by many Short Wave listeners including SWL Deepak Sarma, SWL Alakesh Das and this author, when Mr. Hegde, VU2HEG demonstrated the operation of his state-of-the-art FT77 transceiver by contacting a very special station located in a small village 170 Kms South of Madras. The blind genius of amateur radio - Mr. Chakravarty, VU2TTC introduced himself to the SWLs (in Guwahati) via VU2HEG and an on-the-air lecture was delivered by him. It was a great astonishment to the radio enthusiasts in Guwahati when they came to know that, Chak, VU2TTC pursued his career in ham radio only when he went completely blind and that he was running a completely home-made radio station to his credit!

## PUBLIC BROADCASTING AND AMATEUR RADIO : THE INDIAN SCENERIO

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The history of ham radio began in India as early as 1925 when Nobel laureate Sir J. C. Bose, who was an ardent radio experimenter, recommended Lokendra Bose for an experimenters permit and he got it from the authority with a callsign VU2AG (the first amateur radio station that belonged to an Indian). However it was back in 1923 when amateur radio operation was started in India by 20 British citizens.

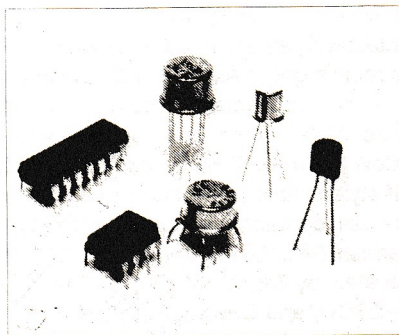
India's first short wave public broadcasting station belonged to Dr. Matcalfe, VU2KH, a leading radio amateur and who was the Vice-Chancellor of Mysore University. He and his group of radio amateurs established an entertainment public broadcasting station, VU6AH in the year 1935 and had listeners all over India.

While world's first broadcasting station became operational from as early as 6th November 1919, which belonged to a Dutch ham-Hanzo Idzarda. Hanzo started public broadcasting with a callsign "PCGG" from Hague with his home brewed transmitter and his programmes became popular around the globe as "Hague Concerts". In the USA, the credit went to a ham Dr. Frank Conrad from Pittsburg, who started public broadcasting with his callsign "8XX" from the beginning of 1920.

## DEVELOPMENT OF ON-THE-AIR COMMUNICATION AT A GLANCE

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The development of on-the-air communication is the result of the experiments carried on by amateur radio experimenters, their ideas, circuitries being absorbed by the electronics industry with fascinating results. In fact the core for development of modern military communication equipments was provided by the technical progress made by the radio amateurs. The Single-side-Band (SSB) transmission technique being one.

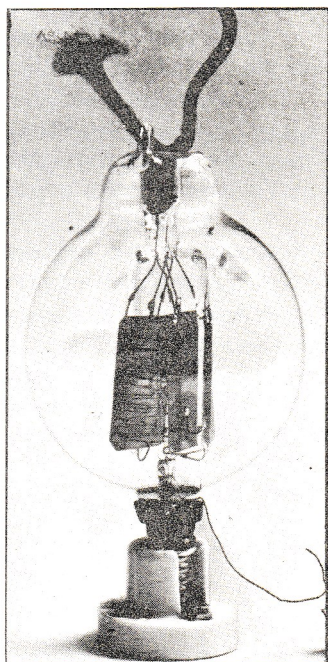


Semiconductor devices that revolutionised the communication system



Many inventions were responsible for the rapid technical progress made in the field of electronics communication. These inventions followed since Heinrich Rudolph Hertz (Germany) produced the longer wavelength electromagnetic waves, called the Hertzian waves, in the year 1888. Next to him was Oliver Joseph Lodge of England who developed a 'resonance oscillator circuit' in 1896 and simultaneously energetic promoters of radio like Marconi carried on experiments on practical application of these inventions. While in the year 1904, Alexander Fleming (England) developed the Vacuum diode, which was a major step forward in the field of radio communication. In the next step Lee De Forest in the USA in 1906 developed the triode valve by modifying the diode valve, where electron current could be regulated by a control electrode called 'grid' placed between the two electrodes of a diode. It gave boost to radio technology so far as voice modulated transmission was concerned. Following it multi electrode valves were developed and transmitting and receiving equipments became smaller, more efficient and more reliable.

The invention of the transistor made up of semiconductor material revolutionized the whole electronics communication system. Portable and cheap wireless transmitter and receiver sets were developed and then came the computer era. Information interchange through computer, teleconference being introduced with the growing interest in RTTY, ATV, Satellites etc.



The first triode valve constructed by Lee De Forest (1907)

## **GOING TO APPEAR FOR THE AMATEUR STATION CERTIFICATE EXAMINATION**

**T**he amateur station certificate examination is conducted by the Wireless Planning and Co-ordination wing (WPC-wing) of the Ministry of Communications, New Delhi at the Monitoring stations located around the country. In the North Eastern region, the examination is conducted at **Wireless Monitoring Station, Lapalang, Rynjah, P.O. Umpling, Shillong-793006**. Contact the Officer-in-Charge of this station for more information and write for an application

form (Landline/ phone number of this station is 24739). More information regarding the examination can also be obtained from:

**Assistant Wireless Advisor, WPC Wing, Ministry of Communications, Room No. 221, 2nd floor, Sardar Patel Bhavan, Parliament Street, New Delhi 110001.**

The amateur examination is held for four different categories of licence. They are the : Advanced grade, Grade I, Grade II, and restricted Grade.

The examination consists of a written paper and a practical on 'Morse code' sending and receiving. The written paper consists of two sections- one on radio theory, electronics and practices and second on national and international radio regulations applicable to operation of amateur radio station.

The candidates who are degree holders in electronics and telecommunications engineering from a recognized University are exempted from appearing section-I of the written paper.

In case of the Restricted and Grade II examinations, the written paper is of one hour duration. The candidate must secure 50 percent in aggregate for a pass. While candidates for Restricted Grade are exempted from morse sending and receiving. Candidates for Grade II must be able to send and receive five words per minute. For Grade I examination the written test is of two hours duration. Further, candidates are required to receive a test piece of 300 characters including letters, figures and punctuations sent in morse code at a speed of 12 words per minute. A similar passage has also to be sent at the same speed. For Advanced Grade, the written paper is of three hour's duration.

## **THE SYLLABUS**

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The detailed syllabus of Amateur station certificate examination is given below :

### **SECTION I**

#### **RADIO THEORY AND PRACTICE**

Elementary electricity and Magnetism : Elementary theory of electricity, conductors and insulators, units, ohms law, resistance in series and parallel, conductance, power and energy, permanent magnets and electromagnets and their use in radio work, self and mutual inductance; types of inductors used in receiving and transmitting circuits, capacitance, construction of various types of capacitors and their arrangements in series and/ or parallel circuit.

#### **THEORY OF ALTERNATING CURRENTS**

Sinusoidal alternating quantities-peak, instantaneous, RMS average values, phase, reactance, impedance; series and parallel circuits containing



resistance, inductance, capacitance; power factor, resonance in series and parallel circuits, coupled circuits, transformers for audio and radio frequencies.

## **THERMIONIC VALVES**

Construction of valves, thermionic emission, characteristic curves, diodes, triodes and multielectrode valves; use of valve as rectifiers, oscillators, amplifiers, detectors and frequency changers, power packs, stabilisation and smoothing, elementary theory and construction of semiconductor devices, diodes and transistors.

## **RADIO RECEIVERS**

Principles and operation of TRF and Superheterodyne receivers, CW reception; receiver characteristics, sensitivity, selectivity, fidelity; adjacent channels and image interference; AVC and squelch circuits; signal to noise ratio.

## **TRANSMITTER**

Principles and operation of low power transmitter; crystal oscillator, stability of oscillators.

## **RADIO PROPAGATION**

Wavelength, frequency, nature and propagation of radio waves; ground and sky waves ; skip distance, fading.

## **AERIALS**

Common types of transmitting and receiving aerials.

## **FREQUENCY MEASUREMENT**

Measurement of frequency and simple frequency meters.

# **SECTION II**

## **RADIO REGULATIONS**

(a) Knowledge of - (i) The Indian Wireless Telegraph Rules 1973, (ii) The Indian Wireless Telegraph (Amateur Service) Rules 1978. (iii) The Indian Wireless Telegraph (Amateur Service) Rules 1978, amended in 1985.

(b) Knowledge of International Radio Regulations as relating to the operation of amateur station with particular emphasis on the following. :

Designation of Emission, Nomenclature of the frequency and wavelength, Frequency allocation to amateur services, Measures against interference, Interference and tests, Identification of stations, Distress and urgency transmissions, Amateur stations, Phonetic alphabets and figure code (Appendix).

(c) Standard frequency and time signals services in the world;

(d) The following 'Q' codes and abbreviations which shall have the meaning as assigned to them in the International Telecommunication Union (ITU) convention :

QRA, QRG, QRH, QRI, QRK, QRL, QRM, QRN, QRQ, QRS, QRT, QRU, QRV, QRW, QRX, QRZ, QSA, QSB, QSL, QSO, QSU, QSV, QSW, QSX, QSY, QSZ, QTC, QTH, QTR and QUM.

Telegraphic abbreviations : AA, AB, AR, AS, C, CFM, CL, CQ, DE, K, NIL, OK, R, TU, VA, WA, WB.

## BOOKS AND PUBLICATIONS

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The International Student edition of the book entitled "Electronic Communication" by Robert L. Sharder, W6BNB published by McGraw- Hill International Book Company, covers the entire theory portion. This is an excellent book which I recommend to start with. **Guide to Amateur Radio in India** -by Saad Ali, VU2ST (Federation of Amateur Radio Societies of India, 4, Kurla Industrial Estate, L.B. S. Marg, Ghatkopar, Bombay-400 086) gives all the information required for Amateur Radio Examination including questions and answers for the exam. Another book- **ABC of Amateur Radio in India** by Mr. Rajesh Verma, VU2RVM can be obtained from Electronics For You (EFY) enterprises Pvt. Ltd., 605 'Siddhartha', 96 Nehru Place, New Delhi 110019 at the cost of Rs. 60/- plus postage.

This book is excellent in the sense that the whole course is covered in a nutshell. There are also lots of foreign books on amateur radio of which books published by Radio Society of Great Britain (RSGB) and American Radio Relay League (ARRL) are supplied by FARSI, C/O Pillar Induction Pvt. Ltd., Block A-13, 2nd Avenue, Annanagar, Madras 600102. or from K. R. Associates, Post box 725, Madras-600 006. and National Institute of Amateur Radio.

Radio Netherlands (South Asian English Service) also conducts some "Technical Courses" free of cost. The following are the courses : (1) All-round DXers course, (2) Short Wave Antenna Course, (3) Radio Spectrum Course, (4) Short Wave Propagation Course, (5) Satellite for Short Wave Listeners and (6) Radio Components Course, (7) Writing Useful Reception Reports.

You can also listen to Radio Netherlands' weekly Communication magazine- "Media Network" at 14:20 IST on 21.485 MHz in the 15m band each Thursday (Please confirm latest schedule). The programme is directed and compiled by Jonathan Marks, who himself is an amateur radio operator, while 'Media Network's' South-Asian Correspondent Victor is also an amateur radio operator; his station 4S7VK is located in Sri Lanka.

Media Network's address is : Radio Nederland, P.O. Box 222, 1200 JG Hilversum, Holland.



## ORGANISATIONS WORKING FOR THE PROMOTION OF AMATEUR RADIO IN INDIA

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There are a number of organisations working for the promotion of amateur Radio in India. **FARSI-Federation of Amateur Radio Societies of India** was founded in 1972. It publishes a monthly amateur radio journal- 'RADIO' Which can be obtained from the address already given above.

FARSI- also runs a QSL Bureau to deal outgoing and incoming QSL cards; the address is P.O. Box 6538, Bombay-400 026, so sending QSL cards or Reception reports to overseas station is not a costly affair for an amateur radio station.

**Amateur Radio Society of India-ARSI** is another leading organization, its headquarter is located in New Delhi, **Amateur Radio Association**, New Delhi once sent representative to Indian Antarctic Scientific Expedition (1983-1984) team.

Another recently, founded organisation is the '**National Institute Of Amateur Radio**', Hyderabad. Department of Electronics (DOE), Government of India allotted funds to this institute. Cyclostyled 'notes' for the radio enthusiasts going to appear for the Amateur Station Certificate Exam. can be obtained from this institute; The address- **National Institute of Amateur Radio (NIAR)**, 6-3-1092/92, somajiguda, Hyderabad-500482. NIAR also provide training course on morse sending, reception and other practical aspects of amateur radio.

**Indian DX Club International -IDXCI** is a club exclusively meant for the Short Wave Listeners (SWLs). They publish a journal- Asian DX-Review. Ask them for more information with a SASE at the following address : IDXCI, G.P.O. Box 646, Calcutta-700 001.

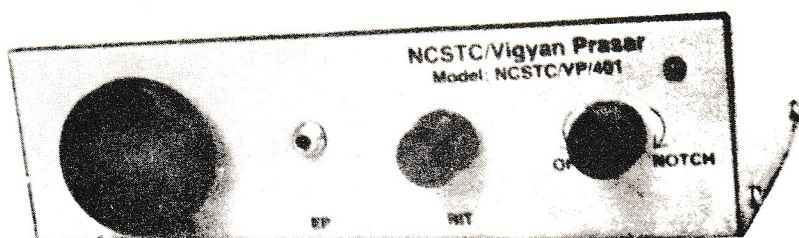
**Society for The Promotion of Amateur Radio- SPAR**, Cochin publishes its monthly communications magazine 'Zero-Beat'. Address for communication is : Society for the Promotion of Amateur Radio-SPAR., Mezzanine Floor, Kannanthanam Chambers, Cochin-682 016.

The international amateur radio magazines like Practical Wireless, Amateur Radio, CQ, 73s etc and available in the metroplitan cities which are of couse very costly to afford. Yet old issues are avilable at very reasonable prices in the roadside bookshops in big cities.

The recently founded amateur radio organization in India is the '**Indian Council for Radio Amateurs**'- ICRA, New Delhi, which has the representatives from FARSI, NIAR, ARSI AND Department of Electronics (DoE), Govt. of India, New Delhi. Wireless Planning and Co-ordination wing & Ministry of Communications.

**Vigyan Prasara** is an autonomous organization engaged in popularization of Science and Technology. Recently it also started its project on developing low cost easily affordable ham radio sets. Vigyan Prasara is a wing of the **National**

**Council for Science & Technology Communications**, Department of Science and Technology. The NCSTC Amateur Radio Club station VU2NCT, under the able guidance of **Mr. Sri Ram, VU2TDZ** and **Dr. V. B. Kamley, VU2VBK**, is presently engaged in manufacturing sophisticated ham radio equipments. The most recent one released for sale on a non-profit basis is a 5 Watts, 7000 to 7100 KHz Transmitter cum receiver which costs Rs.750/- only. So even if you are not experienced in assembling electronic circuits, you can expect to come on-the-air with such a low cost readily assembled kit. The address for communication is : **NCSTC Amateur Radio Station VU2NCT, National Council for Science & Technology Communication, Department of Science & Technology, Technology Bhavan, New Mehrauli Road, New Delhi-110 016** (Phone no : 657520, 655985)



A low cost (price Rs. 750/-) amateur transceiver developed by the NCSTC (National Council for Science & Technology Communications), New Delhi. It may be noted that NCSTC is the organiser of Bharat Jan Vigyan Jatha. Its Director Dr. N. K. Sehgal was awarded the Kalinga Award by the UNESCO for the popularization of science in India.

## AMATEUR RADIO STATIONS LOCATED IN LEADING EDUCATIONAL INSTITUTIONS WITHIN THE COUNTRY

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**S**ome of the amateur stations in India are located at the leading educational institutions of the country. For example Indian Institute of Technology (IIT) has its amateur radio stations. The callsign and location of IIT and other stations are

VU2QQ- Indian Institute of Technology Kharagpur

VU2IIT- IIT, Kanpur

VU2NCS- IIT, Madras

VU2UFO- Directorate of Youth Welfare, Jadavpur University, Calcutta.

VU2BIT- Birla Institute of Technology, Ranchi.



VU2BRC- Birla Institute of Technology, Pillani.

VU2REC- Karnataka Regional Engineering College, Mangalore

VU2TEC- Banaras Hindu University.

VU2YSG- Electronics and Communication Dept., St. John's Engineering College, Mysore.

VU2URC- Upagraha Amateur Radio Station,  
Indian space Research Organization-ISRO, Satellite Centre,  
Bangalore.

VU2UPT- Uttar Pradesh Electronics Corporation Ltd. UPTRON, Lucknow.

**VU2VKP- National Institute of Amateur Radio Club Station, I.E.T.E.  
Centre, Guwahati-3**

(The centre organized a lecture-cum-demonstration on 19/12/90)

VU2GJZ- North Eastern Hill University- NEHU, Shillong.

VU2SCI- Nehru Science Centre, Bombay.

VU2CSC- Dr. Vikram Sarabhai Community Science Centre. Ahmedabad.

Community Science Centre (CSC) at Ahmedabad which was started in 1966 by late Dr. Vikram Sarabhai has a Radio Club-VU2CSC which helps students learn principles of sound and radio waves, radio circuits, electricity, magnetism, and transmission of Morse code. Students build Wireless communication sets and speak to radio hams in various corners of the world. Dr. Sarabhai and few other scientists at the Physical Research Laboratory started this to stimulate innovations and experiments in science education.

## **AMATEUR STATION LOCATED IN THE UNO AND SOME OTHER UNIVERSITIES OF THE WORLD**

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Amateur Radio has its own Beacon Service (Beacon is nothing but a 'signal' transmitted from a particular station identifying itself) Stations. The United Nations Organizations (UNO) in New York city has the amateur radio station 4U1UN, which is operating from the 40 th (top) floor of the United nations Secretariat Building in Midtown.

Its beacon 4U1UN/B comes exactly on the hour and transmits the text for 58 seconds, after two more seconds, that is on the 1st minute after an hour, the **Stanford University**, California beacon W6XB/B comes on followed by **Honolulu Community College**, Hawaii station KH60/B, Japan Amateur Radio League Beacon, station JA21GY/B then **Tel Aviv University** beacon 4X6TU/B, Israel followed by **Helsinki Technical University** station OH2B, Finland, Madeira Island beacon CT3B and south African beacon ZX6DN/B. 4U1ITU is another UNO station located in Geneva.

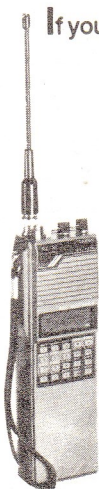
The usefulness of these beacons are that they provide indication of propagation conditions between any two locations worldwide, act as an inband



The United Nations Amateur Radio Station 4 U1UN.

(the frequency being 14.100 MHz) frequency reference for wireless experimenters experimenting with transmitters. It also provide reliable checking facility for the rotatable beam antennae used by radio amateurs around the globe.

## VHF Vs. MORSE CODE



If you are really interested in appearing for the Amateur Radio examination, then you must learn "morse code". In Japan to encourage the young radio enthusiasts, novices are awarded with a 'No Code Licence' which allow them to come on the 14m band even without learning Morse code. But the Indian Radio Regulations have no provision for such no code licence and the radio amateur is bound to learn Morse code to become a ham. Ofcourse if you fail in that practical test, you may yet get a 'Restricted Grade' Licence which will allow you to come on the Very High Frequency (VHF) 144-146 MHz band with 10 watts power only. But this VHF band in practical can be used for Walkie-Talkie operation within a radius of few kilometers only.

This is because VHF (the TV audio/ vision frequency also falls in the VHF band) signal propagates only in line-of-sight, i.e., both transmitting and receiving antenna should see each other. Even

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A hand held VHF transceiver. VHF is very useful in an area where the amateur radio poulation is very dense. The Bangalore hams are very much active on VHF.

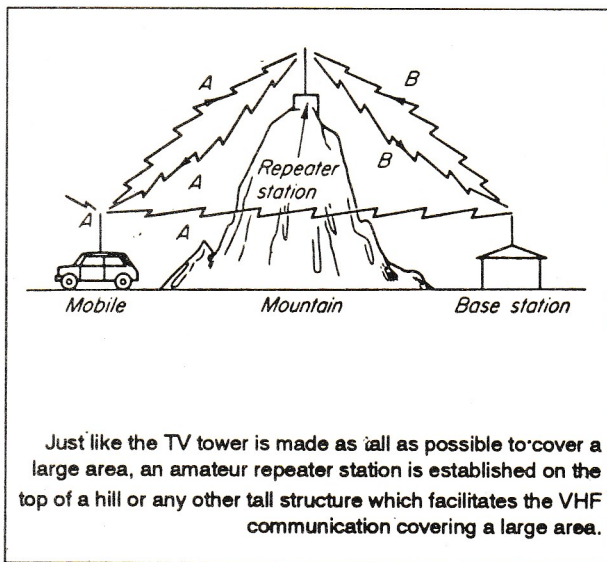
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a tall building may cause difficulty in the propagation of VHF signals. the VHF signals are not reflected or refracted back from the ionosphere; they penetrate the ionosphere and are lost in space! To reflect back the VHF signals from the space, artificial communication satellites are placed into orbit. But when you get a restricted grade authorization you will not be allowed to use amateur radio satellites, that is, only terrestrial operation is allowed, and you will find it hard to carry on your experiments as you may not find other hams like you at your vicinity. So donot neglect Morse code if you are in an area where ham population is not dense !

## THE ADVANTAGE OF VHF

**T**hough we have discouraged you a bit regarding VHF, still it provides lot of fun and hours of experimentation to a ham. Long distance VHF TV reception is a freak phenomenon which fascinates radio enthusiasts all over the world. Ham radio stations look for such rare phenomenon and make use of it for their own long distance VHF communication and take the opportunity to create record, break older records. Radio amateurs look for Co-Channel (same frequency) interference from one TV station to another TV station located hundreds of kilometers away, so that they can assume that patches of high ionization sporadic E-clouds are generated around the equator which is



a favourable condition for their long distance propagation experiments in the VHF band. Imagine that Australian TV operating on 46.25 MHz vision carrier frequency was once received by viewers in Great Britain without any satellites! The freak atmospheric phenomenon like 'temperature inversion', 'Tropospheric ducting' are referred to as the reason behind such kind of long distance VHF propagation.

One of the advantage of VHF is that the size of the VHF equipments are very small and you can carry them inside your pocket ! While visiting an unknown city you can take with you the VHF radio to make contacts with your ham friends and take necessary guidance. In some big cities the radio amateurs are very much active on the VHF band and they also operate round the clock emergency nets. In India, there are a total of 10 repeater stations for VHF operation in the amateur band. The function of a repeater station is to retransmit the VHF signals transmitted by a ham operator to a much longer distance, may be with a much higher power. To cover a large area such **REPEATER STATIONS** are established on top of tall buildings or on top of hills or mountains.

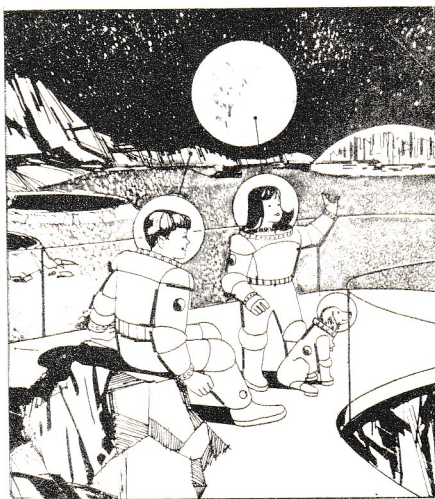
The two hams active with home made VHF equipments in the North East are Mr. Ranjit Chaliha, VU2RCH (Nagaon) and Mr. Anong Perme, VU2ARJ (Itanagar).

The **Calcutta VHF Amateur club** has been established recently under the guidance of Mr. Avinash Misra, VU2EM. and low cost VHF kit is designed by the club. The cost will be around Rs. 1000/- The address for communication; Avinash Misra, VU2EM, 51-A, Kankulia Road, 1st Floor, Ballygunje, Calcutta-700029

## MOONBOUNCE VHF PROPAGATION

**M**oonbounce is another way of amateur communication worldwide on VHF, UHF or microwave. Radio amateurs refer to it as E.M.E. i.e. Earth-Moon-Earth and this describes exactly what happens; your radio signal leaves the Earth, is reflected back off the moon, and comes back to earth. The reflected signal spreads out, and can be received at any place on earth where the moon is above the horizon.

One of the biggest thrills in amateur radio is the first time you let go of the key and actually hear your own voice or signal come back off the moon! In the near future when the moon will be explored by human and establish Lunar Cities there, amateur stations that will be located there will communicate with the amateur radio stations located on earth. Is it not amazing?



Lunar City : Amateur radio communication with outer space colonies- dream or reality?



The moon, had been in orbit for some 5 million years or more and was used as a natural communication satellite as early as 11 January, 1946, when the U.S. Army Signal Corps bounced radar (Radio detection and ranging) signals off the moon during Project 'Diana'. On 29 November, 1959, voice transmissions were relayed from Holmdel, New Jersey to Goldstone, via this same natural satellite. The Moon was also used as a reflector of radio waves by the U.S. Army in the 1950s when existing channels between the US mainland and Hawaii failed because of atmospheric disturbances.

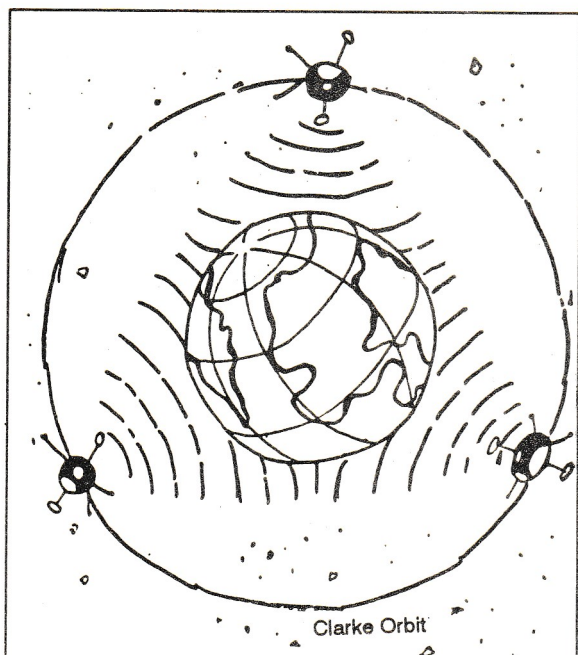
Frequencies allocated to amateur stations, e.g. 144 MHz, 434 MHz and 1.3 Gigs Heritz can be used by amateur radio stations for MOONBOUNCE COMMUNICATION.

## AMATEUR RADIO COMMUNICATION SATELLITES SINCE 1961

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**R**adio communication via artificial satellite is one of the important aspects that fascinates amateur radio operators because of the fact that Satellites provide the most reliable and efficient communication link round the clock. The satellites overcome the problems involved in spanning oceans and continents with submarine cables, landlines and terrestrial microwave relay stations for the long-distance transmissions of radio, telephone and television signals; since the microwave of VHF travels in a straight line, relay stations to receive, amplify and retransmit signals, must be spaced 35 miles or so because of the curvature of the Earth. The cost of providing enough stations to encircle the world completely would be prohibitive. If a satellite at a distance of 35,000 Km above the Earth at the equator (known as 'Clarke orbit') is in a synchronous orbit-it appears to remain stationary over a particular spot on earth. It becomes a relay station that can be seen by any two points on a hemisphere. Three satellites spaced at 120 degree intervals about the equator effectively cover the entire globe and presently there are more than 2,000 satellites high above along with a number of amateur communication satellites, which are ofcourse orbital in nature.

Radio amateurs from countries like the USA, the USSR, Japan, Germany, Australia launched a number of Ham satellites for the use of the hobby stations all over the world. These satellites however are not geostationary, i.e. they are orbital in nature revolving over different places at periodic interval and maintaining communication link for 1/4 hour over each place throught out the hemisphere. amateur Radio operators are thinking of putting geostationary ham satellites into orbit in the near future, when amateur radio stations all over the globe can communicate via these satellites round the clock with any point on earth irrespective of the prevailing ionospheric propagation condition. In fact the importance of ionosphere will be lessened at the same time providing most reliable instant communication link between any two points on earth.



The visionary idea of Arthur C. Clarke that only 3 satellites at 120 degrees interval, 35,000 Kms. above the Earth can cover the whole globe by radio & TV came true very soon. The geostationary orbits where these satellites are placed are formally recognised as 'Clarke Orbits'. Amateur satellites are but orbital, not geostationary.

The first Orbital Satellite Carrying Amateur Radio-OSCAR 1 was launched by the radio amateurs from USA, with only 0.1 watt transmitter on December 12, 1961. OSCAR-1 was on the orbit for 21 days transmitting its telemetry beacon 'HI' (morse code used by radio anateurs to indicate that he is in jolly mood !) in morse code which was received by more than 600 amateur radio stations of the world for more than 5,000 times.

## WHAT IS A BEACON?

The beacon is nothing but a radio signal, usually in coded form transmitted from a particular station to identify itself. OSCAR-1 was operating on 144.98 MHz beacon frequency Transmitting the code HI in Morse code (... ..).

OSCAR-2 was launched on June 2, 1962 which survived for 18 days in space.

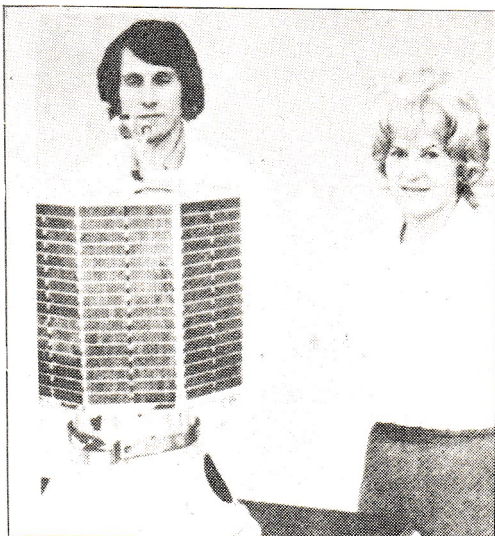
OACAR-3 was launched on March 9, 1963 which carried a 2m to 2m (144 MHz) transponder).



## WHAT IS A TRANSPONDER ?

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A transponder is a combined unit of transmitter and receiver systems that automatically transmits a signal when it is triggered/activated by another signal transmitted from a ground based amateur radio station. For example OSCAR-3 had its transponder which accepted input radio signals from ground amateur radio stations at 144.1 MHz and re-radiate them at 145.9 MHz. So what you transmit in 144.1 MHz can be listened on 145.9 MHz only. A separate VHF receiver at your radio room which you tune to 145.9 MHz, when receives your signal indicates that you are in contact with the satellite.



Jan King W3GEY AMSAT-OSCAR-B Project Manager and Marie Marr, AMSAT's Aerospace technician, with the spacecraft.

In addition to the transponder, OSCAR-3 had a 0.5 Watt telemetry beacon operating at 145.85 MHz.

## WHAT IS TELEMETRY?

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Telemetry is the science of measuring a quantity; then transmitting the measured quantity/ value to a distant station where these data transmitted by means of radio wave are intercepted recorded and/ or analysed for utility. OSCAR-3 was active for 14 days transmitting various scientific data collected in the space and during its lifetime about 100 amateur radio stations around the globe made two-way contacts including transatlantic calls. Amateur Radio Satellites send continuous morse code telemetry on their primary beacon frequencies. This telemetry is arranged in blocks. For example a telemetry message from the Radio Sports Satellite might look like: K00 D75 084 G01 U01 S17 W18 RS 3. The block consists of seven sections and a call sign. (RS3). Each

section contains one or two letters and two figures. In the above example various information like output power, voltage, charge current, satellite temperature, transmitter temperature etc can be decoded also the information whether the transponder is ON or OFF can be known. In this telemetry according to data available by the radio amateurs the letter K is equivalent to the value 0.2 and to get the power of the transmitter the formula to use is  $K \times 0 \times 0 = 0.2 \times 0 \times 0 = 0$ , that means the satellites transponder is 'off'.

## THE FIRST AMATEUR SATELLITE COMMUNICATION LINK BETWEEN THE USA AND THE USSR(ERSTWHILE)

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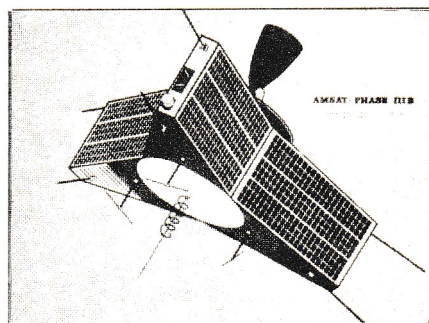
**O**SCAR-4 was launched in December 21, 1963 with its 2m to 70 cm transponder when amateur radio contacts between the USA and The USSR were made via it for the first time.

With the rising interest in Orbital Satellite Carrying Amateur Radio-OSCAR, Radio Amateur Satellite Corporation (AMSAT) was formed which co-ordinate the efforts of hams from the USA and the other countries.

The amateur radio hobbyists of Melbourne University, Australia then launched the next satellite of the OSCAR series, OSCAR-5 on January 23, 1970. This was

the first satellite which was provided with a High Frequency (HF) beacon at 29.45 MHz along with another VHF telemetry beacon at 144.05 MHz. The 29.45 MHz telemetry beacon was so designed that it could be switched on by the command of a ground station and thus provided valuable experience in telecommand systems.

The result of joint efforts by the Australian, German and American hams was the launching of OSCAR-6 on October 12, 1972 which carried a 2m (144 MHz) to 10m (29 MHz) transponder; two beacon operating on 10m and 70cm bands. OSCAR-6 had a unique capability of storing coded messages of 18 words length in morse code and 22 words in Teletype messages. OSCAR-6 was active for 5 years on the orbit.



An artist's impression of OSCAR-10



OSCAR-7 with two repeater/ transponder at 145 to 29 MHz, 432 to 145 MHz along with four beacons was put into orbit on November 15, 1974.

The Soviet ham satellites named Russian Radio Sport Satellite RS-I and RS-II were provided with 2m to 10m repeaters and telemetry beacons which were used for scientific and educational experiments for two days every week. The rest of the days were available for amateur radio stations throughout the world. Since then the Russian hams put into orbit a total of 10 amateur satellites under the Radio Sport series named RADIO-1 to RADIO-11. In the OSCAR series also there are 11 satellites put into orbit till today.

## **ROBOT IN THE AMATEUR SATELLITE**

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The RS-10 and RS-11 are equipped with robots and microprocessors that enables literally conversation with the satellites. Even very moderately sophisticated radio equipments can be used to work these satellites. For example a transceiver without VHF band can be used to work them. You can use an UPLINK frequency of 21.120 MHz and receive on a DOWNLINK frequency of 29.403 MHz. You can command the robot of the ham satellite to send morse code at a slower speed while the robot can also command you to send morse code at a greater speed or slower speed which corresponds to your manual speed in using the morse key !

The amateur radio satellites are usually placed at near circular orbit of 1460 Km with 101.7 degrees inclination and orbiting period of 115 minutes. Communication link within a radius of 3,000 Km can be maintained from a given location for a maximum of about 30 minutes at precalculated time intervals when the satellite is overhead.

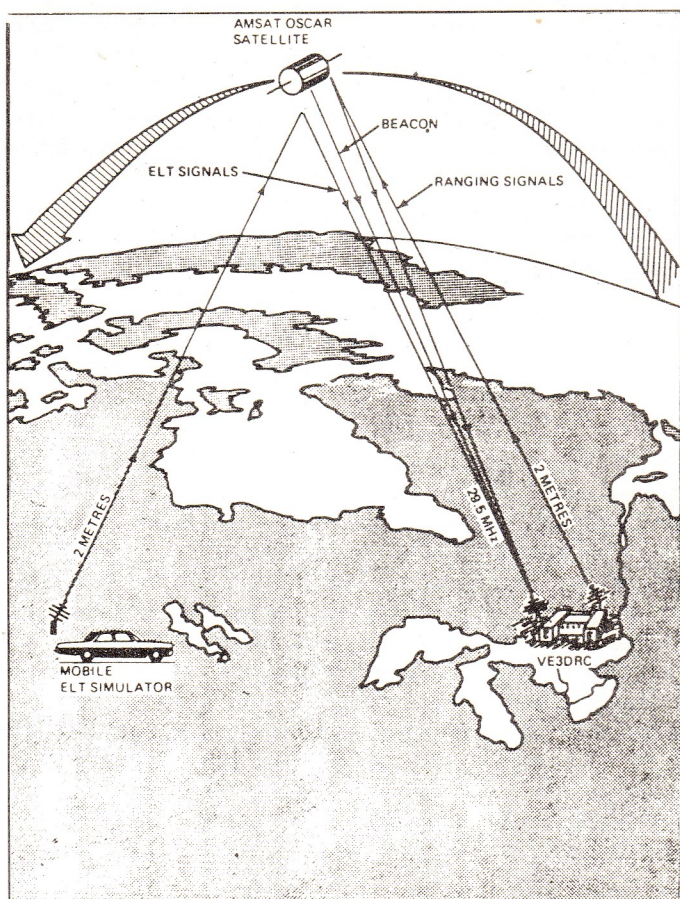
## **UTILITY OF THE AMATEUR RADIO SATELLITES**

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The amateur satellites are tracked by amateur radio club stations located in different schools around the world and used by children for learning science and mathematics and also for learning foreign languages.

Radio amateurs successfully demonstrated their utility by providing emergency communication link, for locating downed aircrafts through their emergency locator transmitter.

Relaying of the 'electrocardiogram' of a patient from a moving ambulance in a remote area to a distant hospital for diagnosis and proper medical advice was also once demonstrated by amateur radio stations using their own ham satellites. More information regarding Amateur radio Satellites can be obtained from: AMSAT-UK Mr. R. Boradben G3AAJ, Hon. Sec. AMSAT-UK 94 Herongate



Experiment conducted by radio amateurs to locate crash sites of vehicle with the help of AMSAT OSCAR SATELLITE and a computer interface at the base station. The above picture illustrates the conception of the emergency locator experiment used for locating crash sites. The computer interface was located at the Amateur Radio Station VE3DRC. Tests showed that the crash could be pinpointed to within a few miles of the actual site.

Road, Wanstead Park, London. E125 EQ Telephone: (0483) 61707. or UOSAT University of Surrey Dept of Electronics & Electrical Eng. Guildford, Surrey, GU2 5XH

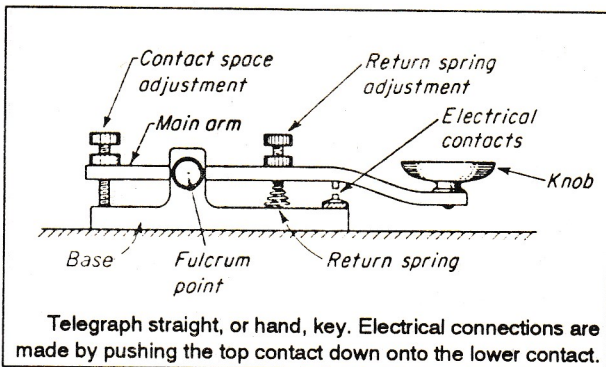
At the end of this brief profile on amateur radio, we are going to give you tips on learning morse code.



# LEARNING THE MORSE CODE

The telegraphic code used for amateur radio telegraphic communication is the International Morse Code consisting of dot (.) and dashes (-). In international morse code, a

dot (.) is made by pressing the telegraph key (Switch) down and allowing it to spring back up again rapidly; and for making a dash (-), the key is held down for a bit longer period, that is not sprung back rapidly.



## THE INTERNATIONAL MORSE CODE

|   |          |   |         |   |        |   |           |
|---|----------|---|---------|---|--------|---|-----------|
| A | ._.      | J | ._._._. | S | ... .. | 1 | ._._._._. |
| B | ._... .. | K | ._. _.  | T | - _.   | 2 | .. _._.   |
| C | ._._.    | L | ._..    | U | .. _.  | 3 | ... _.    |
| D | ._..     | M | __.     | V | ... _. | 4 | .... _.   |
| E | ..       | N | ._.     | W | ._. _. | 5 | .....     |
| F | .. _.    | O | __.     | X | ._. _. | 6 | ._....    |
| G | __.      | P | ._. _.  | Y | ._. _. | 7 | __...     |
| H | ....     | Q | ._. _.  | Z | __..   | 8 | __._.     |
| I | ..       | R | ._.     |   |        | 9 | __._.     |
|   |          |   |         |   |        | φ | __._.     |

### Punctuations :

|   |                      |         |                          |        |
|---|----------------------|---------|--------------------------|--------|
| . | (Period)             | ._._._. | \$ (dollar sign)         | ... _. |
| , | (comma)              | ._._._. | " (quotation mark)       | ._.    |
| ? | (question mark: IMI) | .. _._. | Error sign (8 dots)      | .....  |
| / | (fraction bar)       | ._. _.  | Separation indicator     |        |
| : | (colon)              | __.     | or BT                    | __.    |
| ; | (semicolon)          | ._. _.  | End of transmission of   |        |
| ( | (parenthesis         | ._.     | a message AR             | ._.    |
| ) | (parenthesis)        | ._.     | Invitation to transmit K | ._.    |
| ' | (apostrophe)         | ._. _.  | Wait AS                  | ._.    |
| - | (hyphen)             | ._. _.  | End of work VA           | ._.    |

To learn morse code you need an electronic device called the 'Code Practice Oscillator' (CPO). It is an audio frequency generator which produces an audible tone. Radio amateurs while learning morse code never try to memorize them as dot and dashes by mere visualization of the dot(.) and dashes (-); but they try to memorize them by hearing the tone and thus for easy remembering of the combination of codes they say dot and dash as Di and Dah respectively. It signifies that you remember the codes by their sounds and not by written figures. The different combination Di and Dah make the alphabets, figures, characters, and punctuation marks.

We refer to dot and dash as di and dah as that how you hear the sound and pronounce them as. The time taken to produce the Sound equivalent to one di or dit (dot.) is taken as unit time and called a dot unit.

A dah is approximately of three dot units length and the space between two sound elements of a letter is one dot unit i.e. silence period is one dot unit.

The space between two letters or characters is equal to three dot units.

The space between two words is equal to five dot units. It all depends on your imagination and experience gathered listening to morse transmissions over your radio.

Learning to send morse code is far more easier once somebody demonstrates it to you. But it is a bit difficult to learn decoding of incoming morse signals ; yet to be a skilled morse sender, it is said that you should first learn decoding of morse code from a prerecorded cassette. Instruction manual, Morse Key, code Practice Oscillator etc. can be obtained from NIAR, Hyderabad or from M/S Pentagon Enterprise, Verma Building, National Highway, Gangtok-737101, Sikkim. The whole package costs Rs.290/- only.

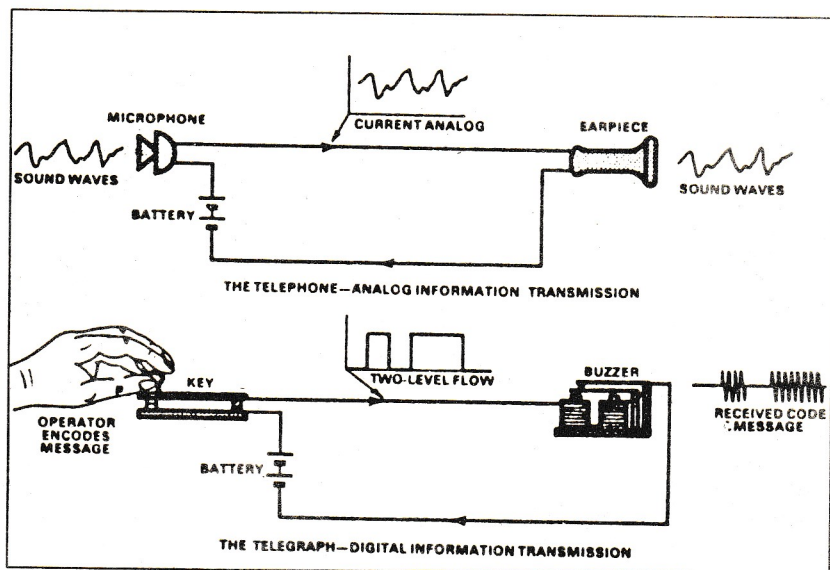
While you sit for Amateur Radio Certificate exam, always remember that Ministry of Communications consider 5 letters as one word.; that means that when you send a message that contains 125 letters and it takes 5 minutes to send, you are at the speed of 5 words per minute which is all you need to sit for the examination;

$125/5=25$  words in 5 minute; ie 5 words per minute.

In fact morse code devised by Samuel F. B. Morse (1791-1872) is a primitive type of digital communication which still works most efficiently even in this era of microprocessors and computers. In a computer all information are processed or stored in binary digits, i.e. 0 and 1s. A zero (0) means that the switch is off and a one (1) makes it on. One interesting fact is that any type of information can be converted to binary digits and later on the information stored in the form of binary digits can be decyphered (decoded).

In the Morse code system the encoding is done by 'short' and 'long' duration of flow of current through a circuit. This method of representing and manipulating information in electrical form is known as digital approach, mainly because the encoded information may often be visualised as a series of numerical digits. The digital approach may seem less familiar than the analog method at first hand, but it has really been in use for a very long time. Most early signalling systems were digital; from the smoke signals of cave man, through fire towers and





mechanical semaphore systems, to the early electrical telegraph systems based on Mors code.

In fact the electrical telephone and telegraph are very simple examples which illustrates the difference between the analog and digital methods. In the telephone, the information is transmitted from one end to the other via a current which varies continuously as a direct equivalent of sound waves striking the microphone- the analog approach. In the telegraph, the information is encoded (cyphered) and sent as a sequence of current/no current pulses illustrating the digital approach.

Once you become proficient in Morse code you can go for more sophistication. As you might have seen while doing a Computer course, ASCII (American Standard Code for Information Interchange) is used in computer programming, ASCII code is also used by amateur radio stations to do computer to Computer communication. In digital communication baudot code is used through teleprinters.

## WHY MORSE CODE IS USED?

Now the question arises why the Morse code is used for radio communication? The reason is that Short-Wave signal in radiotelephone (ie voice transmission) is often subjected to very rapid and deep fading; two frequencies separated by only a few hertz, fade at different times. To overcome this, modulated code tones are transmitted. The situation is now that under sever conditions of fading, the carrier frequency may fade out completely but one or the other sideband may remain strong as result a continuously readable signal is received.

Morse code is called CW, ie Continuous Wave, in the sense that a constant amplitude interrupted radio frequency wave is transmitted; interruption being made in conformity with the code.

## COMPUTERS TO LEARN MORSE CODE

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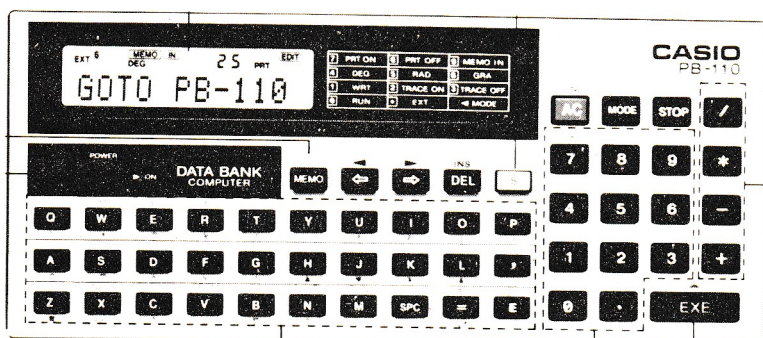
**B**oys and girls can be trained within a short span of time more effectively using computers, Morse Code Packages being published in the magazines like the Electronics For You. Those who are interested can refer to the following issues of Electronics For You (EFY) : August-1986, September-1987, October-1987, February-1988, March-1988.

A simple computer program is given here which will run on an IBM PC compatible computer. When you press a key on the computer keyboard, the computer will play for you the Morse equivalent of that particular key (letter, number, punctuation marks etc.) So you can see that a person who does not know Morse code can send a message to person who knows Morse code by just entering the message to be fed to a wireless transmitter. What you type into the keyboard is heard by the other wireless operator as Morse code !

### The computer programme :

```
5 DIM A$(78)
10 PRINT "I WILL PLAY FOR YOU THE MORSE EQUIVALENT OF A
LETTER"
20 PRINT "PRESS THE LETTER"
30 X$=INKEY$
40 IF X$=" " THEN 30
50 FOR I1=1 TO 78
60 READ A$(I1)
70 NEXT I1
80 FOR J1=1 TO 78
90 IF X$=A$(J1) THEN GOTO 100 ELSE GOTO 110
100 V$=A$(J1+1)
110 NEXT J1
120 DATA A,-,B,-,C,-,D,-,E,-,F,-,G,-,H,-,I,-,J,-,K,-,L,-,M,-
130 DATA N,-,O,-,P,-,Q,-,R,-,S,-,T,-,U,-,V,-,W,-,X,-,Y,-
170 DATA Z,-,1,-,2,-,3,-,4,-,5,-,6,-,7,-,8,-,9,-,0,-
200 DATA ,,-,?,-,.-,.-,.-,.-,.-,.-,.-,.-,.-,.-,.-,.-,.-,.-
210 FOR T1=1 TO LEN(V$)
220 IF MID$(V$,T1,1)="-" THEN PLAY "L24 N48 P24"
230 IF MID$(V$,T1,1)="-" THEN PLAY "L8 N48 P24"
240 NEXT T1
250 GOTO 20
260 END
```



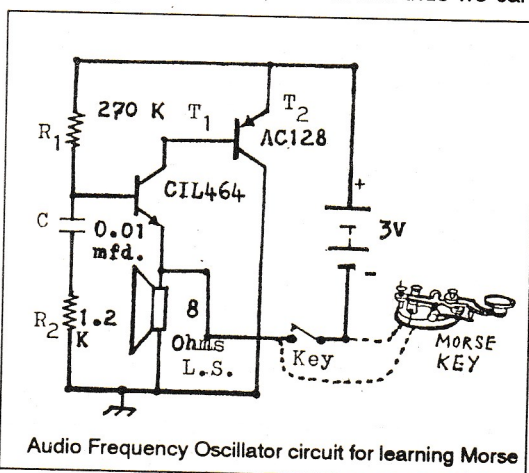


CASIO PB 110, the pocket size personal computer which can be obtained just at the cost of a scientific calculator is provided with a Morse code learning software.

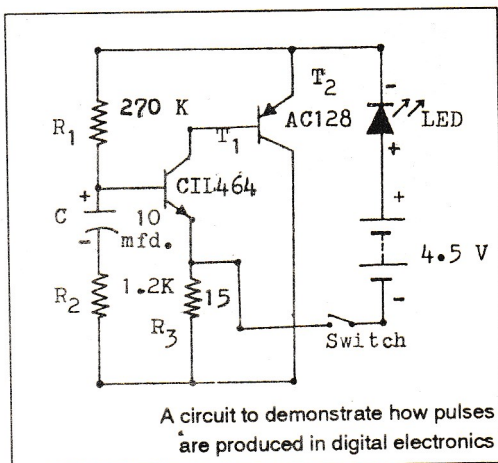
A set of software on HAM radio (Best of HAM radio) can be obtained at the cost of Rs.1499/- from INNOVATION INDIA, 6/8, Siva Prakasam St., T. Nagar, Madras 17. These software include a BZP message handler, PC Ham, PC tracker, Morse Code etc intended to be used on IBM Compatibles.

## THE AUDIO FREQUENCY OSCILLATOR

**A**udio frequency means a range of frequency from 20 Hz to 20,000 Hz (i.e. 20 KHz). The electronic circuit given below consists of two transistors (AC128 and CIL464), one capacitor (0.01 mfd), two resistors (270 Kiloohms and 1.2 Kohms) and a loudspeaker (8 ohms). The circuit is so arranged that it can produce oscillating currents in the range of 20 to 20,000 Hz and thus we can hear it as a tone over the loudspeaker when you make the switch (Morse Key) on. The transistors T<sub>1</sub> and T<sub>2</sub> are arranged in a direct coupled mode of amplifier. Oscillating currents are produced by the positive feedback through capacitor-C and resistor-R<sub>2</sub> from the collector of T<sub>2</sub> to the base of T<sub>1</sub>. As a novice you will find it interesting to see that the same circuit producing audio frequency can be



made to oscillate at a much lower frequency by little modification. For example replace the 8 Ohms speaker with a 15 Ohms resistor and 0.01 mfd capacitor with a 10 mfd electrolytic capacitor and include a LED (Light emitting Diode) as shown in the circuit above. instead of listening to an audio tone you can see that the LED starts blinking at periodic interval, which exactly demonstrates how pulses are produced in digital circuit! The light goes 'OFF' means '0' and the light goes 'ON' means '1'. Otherwise in the MORSE KEY operation, when you make the key 'ON' for a certain period, it is a 'dot' and a longer tone means that it is a 'dash'. Be sure to maintain the proper gap between each tone as we described above.



## MARRIAGE BETWEEN A COMPUTER AND A RADIO

**H**ams are experimenting with AMTOR (Amateur Teleprinting Over Radio) and Packet radio. Packet radio provides the least error transmission of messages in which the amateur station is equipped with a computer which is linked via a TNC (Terminal Node Controller) to the wireless transmitter and receiver and messages are sent involving ASCII Code at a much faster rate which we can not achieve by the Primitive digital communication method like morse code transmission by hand key operation.

Packet frequencies used by amateur radio stations are the following;

|            |                         |
|------------|-------------------------|
| 80m band : | 3611.5 and 3628.5 KHz   |
| 40m band : | 7091.5 and 7098.5 KHz   |
| 20m band : | 14076.5 and 14098.5 KHz |
| 15m band : | 21019.5 and 21098.5 KHz |
| 10m band : | 28091.5 and 28098.5 KHz |

With a basic course on digital communication system we come to the end of our compilation. Hope we could give you a good picture on amateur radio covering its different aspects. But before we end we would like to give you the ham code. Today, radio waves are a precious commodity and so the ham should



not misuse them for his own ends. Paul M. Segal has given us the following code for a ham radio operator.

1. The ham is considerate. He/She never knowingly uses the air (radio waves) in such a way as to lessen the pleasure of others.
2. The ham is loyal. He/She offers his/her loyalty, encouragement and support to his/her fellow hams, his/her local clubs.
3. The ham is progressive. He/She keeps his/her station (radio equipment) abreast of science. It is well-built and efficient. His/Her operating practice is above reproach.
4. The ham is friendly. Slow and patient sending when requested, friendly advice and counsel to the beginner, kindly assistance, co-operation and consideration for the interests of other; these are the mark of the ham spirit.
5. The ham is balanced. Radio is his/her hobby. He/She never allows it to interfere with any of his/her duties he/she owes to his/her home, his/her job, his/her school or community -and lastly his/her knowledge and his/her radio station are always ready for the service of his/her country and his/her community.

Amateur radio is the kindling light that leads the young mind to the depth of the science and the technological applications. In the days to come we hope that our present and future parents will encourage their kids to come on the air. It is the fundamental base upon which freindship and brotherhood can grow among the working people.

So with best of 73s this is VU2MSY Signing Off !

□□□□

### **AIMS & OBJECTIVES OF EWG**

1. To work for the promotion of Amateur Radio (including the hobby of DXing) in the North East.
2. To build a regional Amateur Radio Network in the North Eastern states.
3. To conduct DXpedition to remote areas of the North East.
4. To provide learning & study materials on a non-profit basis to the interested people.
5. To help the Relief Agencies in establishing communication during natural calamities.
6. Ours is a non-profit voluntary group believing in global brotherhood.



**ETHERIAL WHISPER  
GROUP**

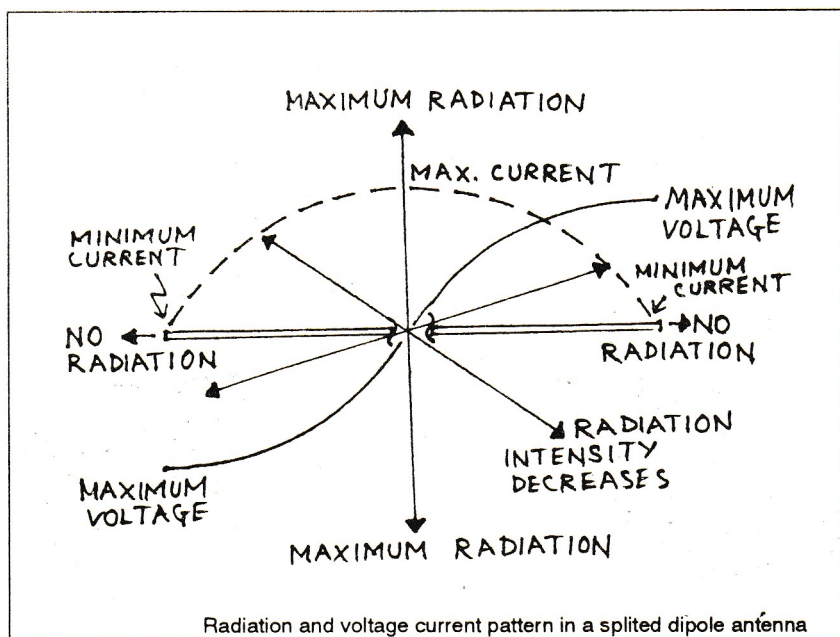
# APPENDIX I

## PROBABLE QUESTIONS & ANSWERS FOR ASOC EXAMINATION

### AERIALS

**Q.1 Describe the working function of the antenna you intend to use in your ham work.**

The antenna I intend to use in my radio work is a dipole antenna. This is a resonant antenna half-wavelength long ( $\lambda/2$ ). Resonant circuits are well known in radio engineering as combination of coils and capacitors, which cause a signal gain at certain frequencies. The same is applied to half-wave dipole antenna.



It consists of two straight wire or rod sections, each  $1/4$  wave long and positioned in one line (Collinear). The antenna is fed in the centre by a coaxial cable having a characteristics impedance of 75 Ohms.

In a  $1/2$  wave dipole antenna, the maximum current flows at the centre and minimum at the two ends. And maximum voltage point appears at two ends while minimum at the middle.

The maximum radiation direction is perpendicular to the axis from the middle point. The cause for directional radiation by a resonant  $1/2$  wave dipole antenna is that the radiation intensity is proportional to the square of the current in the



antenna, and in the dipole current is maximum at the middle; hence the maximum radiation line passes through the middle of the antenna perpendicularly.

### **Q.2 What is 'radiation resistance'?**

When an antenna is excited into oscillation by a RF source, it radiates energy into space acting as a source of power. The antenna, which is the source of power must have an internal resistance or impedance. We have-

Power,  $P = I^2 R$ , Where  $I$  = current,  $R$  = resistance,

$$R = P/I^2$$

So in case of the antenna, radiation resistance is the ratio of the radiated power to the square of the centre current in the antenna.

Radiation resistance is also defined as a fictitious resistance which when substituted for the antenna would consume as much power as the antenna radiates.

Radiation resistance is also called 'Feedpoint' impedance; in case of a dipole antenna feedpoint impedance is nearly 73 Ohms.

### **Q.3. Why half-wave dipoles are fed at the centre?**

(I) Most half-wave dipoles are fed at the centre, because in a half-wave resonant dipole, maximum current point is at the centre of the antenna and this is the minimum voltage point' and it is easier to construct transmission lines for low voltage than for high voltage.

(II) The other reason is that in a  $1/2$  wave dipole the capacitive reactance and inductive reactance cancel each other (the antenna being resonant), leaving resistance only as net impedance. Under this condition, the antenna impedance is the resistance between any two points equidistant from the centre along the antenna length making it easier to match the transmission line impedance with the antenna impedance.

### **Q.4. What is VSWR (Voltage Standing Wave Ratio)?**

When the transmission line does not match the load impedance (antenna impedance), maximum transference of energy to the antenna is not possible. The energy fed down the line is transferred to the antenna only partially; in fact some is reflected back, forming standing waves on the line. Every half-wave along the line, high-E (Voltage) and Low-I (Current) points appear. Halfway between these two points will be low-E and high-I points.

The ratio of voltage across the transmission line at the high-E point to that at low-E points is called the VSWR-Voltage Standing Wave Ratio.

$$VSWR = E_{\max}/E_{\min}$$

$$\text{or, } SWR = I_{\max}/I_{\min}$$

When the load (antenna) impedance matches the transmission line impedance, there will be no standing waves.

$$SWR = 1:1 \text{ or } 1.$$

VSWR is greater than one for a mismatched system and equal to one for a perfectly matched system.

or,

VSWR on a transmission line is caused by power being reflected back to the transmitter from the antenna. If  $P_f$  is the forward power and  $P_r$  is the reflected power measured in watts by a directional wattmeter, then VSWR can also be calculated by the formula:

$$VSWR = \frac{1 + \sqrt{P_r/P_f}}{1 - \sqrt{P_r/P_f}}$$

### Q.5. Why Impedance matching is necessary In an antenna and transmission line system?

Impedance matching is of utmost importance so far as energy transference from the transmitter to the antenna through the transmission line is concerned; because :

(i) Mismatching will prevent maximum output being radiated, i.e. if the transmission line impedance doesn't match the antenna feedpoint impedance, a part of the energy fed down the line will be reflected back from the antenna causing standing waves on the line; it makes the system inefficient.

(ii) Mismatching a transmission line to an antenna results in the line at the transmitter end appearing to have either inductive reactance (xi) or Capacitive reactance ( $X_c$ ), which will detune the Inductance- Capacitance, LC circuit to which it is coupled; mismatching should be avoided so that final stage of the RF amplifier is not detuned.

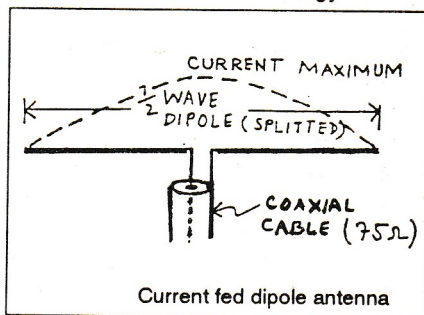
(iii) In commercial equipments, e.g. ICOM IC-735 transceivers, mismatching should be strictly avoided to prevent damage of the circuitry.

### Q.6. What are current fed and voltage fed antennae?

**Current fed antenna :** There are many methods of feeding energy to an antenna. The antenna is said to be current fed when excitation energy from the RF-generator is introduced to the antenna at the point of high circulating currents. The example is a  $1/2$  wave dipole antenna. In this case the  $1/2$  wave antenna is cut in two parts at the midpoint and energy is fed by co-axial transmission line.

In a dipole antenna maximum current flows through the middle point, hence it is current fed antenna with feeding point impedance of about 73 Ohms, which is considerably small as compared to end point impedance of the antenna. Midpoint is the low-voltage point.

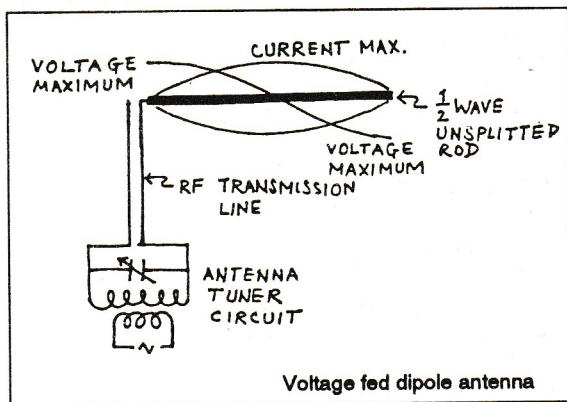
**Voltage fed antenna :** When the excitation energy from the RF Source is introduced at the point of maximum voltage, the antenna is said to be voltage fed antenna. The example is the  $1/2$  wave unsplitted antenna excited by a resonant r-f line; the end of the antenna is connected to only one side of the transmission line. Voltage changes at this point excite the antenna into





oscillation. The impedance at the end of the antenna is high or it is the high impedance point.

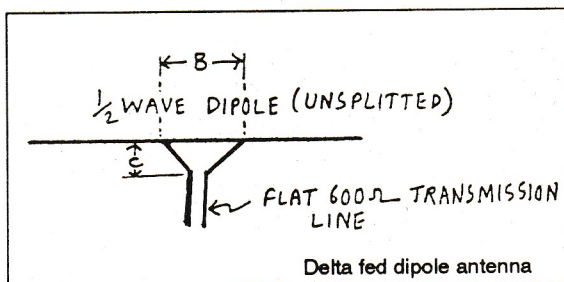
Any multiple of a  $1/2$  wave resonant antenna may be end-fed by using a tuned feeder system leaving one end of the feed line unconnected. This antenna is also called Zepp (used earlier on Zeppelins) antenna.



### Q.7. Write about different types of antenna system impedance matching procedure.

(a) Using the **proper transmission line** for each particular antenna is a way of achieving impedance matching. For example a  $1/2$  wave has a midpoint impedance of 73 Ohms, so coaxial cable transmission line which has characteristic impedance of 75 Ohms is used to feed the r-f energy into the antenna.

(b) **Delta Match:** This type of matching procedure is used with an unsplitted  $1/2$  wave dipole antenna, the dipole being resonant, its capacitive reactance ( $X_c$ ) and inductive reactance ( $X_L$ ) cancel each other, leaving resistance only as net impedance. Under this condition the antenna impedance is resistance between any two points equidistant from the centre and thus



transmission lines having characteristic impedance of 300 to 600 ohms be used by getting two points of the antenna to feed where it offers a feedpoint impedance equal to transmission line impedance.

To do so it is essential to spread out the feeders at the antenna end.

The formula used to make this type of matching are :

$B = (0.25 \times \text{Wavelength}) / 2$ ; where B is the distance between the two feedpoint which will offer 600 ohms impedance;

and  $C = (0.32 \times \text{wavelength})/2$ , where  $C$  is the vertical distance upto which spreader should be spread (the inclination).

(c) **Stub Match** : A shorted stub of  $1/2$  wave length or open stub of  $1/4$  wave can be connected to the splitted dipole.

Here the low midpoint impedance of 73 ohms of the dipole is repeated at the close end of the stub; but there are certain points on the stub which would offer as high as 600 ohms impedance yet matching with 73 ohms feedpoint.

(d) **Gamma Match**: Here outer sheath of the 75 ohms coaxial cable is connected to the middle point of the unsplit dipole while the inner conductor is connected to a point through a capacitor to cancel inductive reactance, so that antenna impedance at feed point is 75 ohms.

Gamma match is slightly unbalanced.

(e) **T-match** : In this type of impedance matching, two coaxial cable are held side by side and both their outer sheaths are connected to the midpoint of the unsplit dipole, while two points are chosen on the dipole where inner conductors going parallel each other (of the coaxial) are connected.

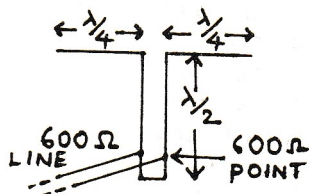
(f)  $1/4$  wave transmission line impedance matching device :

A  $1/4$  wave line can act as an impedance- matching device between high and low impedance circuits if it has the proper intermediate impedance found from the formula :

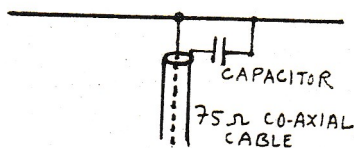
$$Z = \sqrt{Z_1 \cdot Z_2}$$

Where  $Z_1$  = antenna feedpoint impedance;  $Z_2$  main transmission line impedance. When we want to match a 300 ohms transmission line to a 70 ohms feedpoint impedance dipole then the  $1/4$  wave transmission line connected between both the system should have

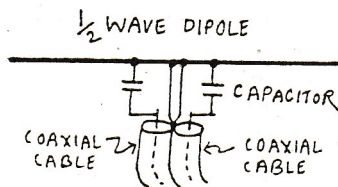
$$Z = \sqrt{300 \times 70} = 145 \text{ ohms}$$



Halfwave shorted stub



Gamma match



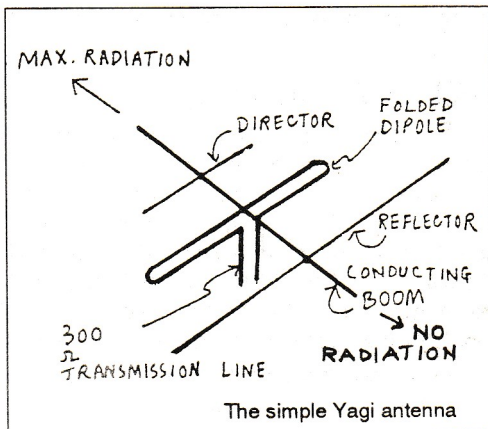
T match



### Q.8 What is Yagi antenna?

When a half wave dipole antenna consists of one or more parasitic arrays, the antenna becomes parasitic beam antenna, named as "Yagi" after its designer proff. Yagi, Japan.

The antenna consists of mainly three elements, the  $1/2$  wave splitted dipole driven element, in front of this driven element is the 5% shorter director element, back of the driven element is the 5% longer reflector. All the elements can be assembled on a single conducting boom.



This antenna has the property of beaming signals in the direction of the director and no signals to the backward direction.

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## WAVE PROPAGATION

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### Q.9. What is the difference between Fade-out and fading?

**Fade-out :** It is the gradual phenomenon that take place with the change of time of the day. Fadeout of radio signal is related to the ionization gradient of the ionosphere which decreases in absence of sunlight. Since ionization is intense during day light hours, higher frequency (like 21 MHz, 14 MHz) of the shortwave spectrum can be used during daylight hours.

But we will find that as night approaches, signal strength at that higher frequency decreases. Using a low SW frequency (7 MHz) will yield satisfactory result to this fadeout.

**Fading :** As distinct from fade-out, fading is the constant variation of the received strength of radio wave. To the listener it appears as gradual rising and falling of the volume. The signal waxes and wanes and at times even drops below usable values. This phenomenon is manifested chiefly in long-distance transmission. It is caused by multiple reflections from the ionosphere which cause two or more waves from the same transmitter travel over different paths of different lengths and hence differ in phase and amplitude when they arrive at the receiving aerial.

**Q.10. Write an account of ionospheric layers and their effects on propagation of different wavelength electromagnetic waves. Explain why different frequencies are to be used during the day and night for contacting the same station?**

\* Refer to above answer and the text.

**Q.11. Describe F2-layer.**

F2-layer is the most important layer for long distance short wave propagation. This layer is found at an altitude of about 250 Km to 400 Km. F2-layer of the ionosphere, formerly called Appleton layer has a high ionization gradient. This layer exists both in the daytime and nighttime. Since at such an altitude air density is extremely low, the free ions and electrons (due to action of ultraviolet radiation from sun) can not recombine readily and so stores of energy received from sun for many hours; and that is the reason the refractive property of this layer changes only to a negligible extent during day and night.

Its ionization gradient varies

- (i) time to time of the day
- (ii) by season
- (iii) by sunspot activity

The path which the shortwave signal following through the F2 layer is in reality a curved one. Degree of curve depends on-

- (i) angle of incidence of the wave
- (ii) ionization gradient of the layer
- (iii) frequency of the signal.

**Q.12. How sky wave contribute in propagation?**

The sky waves radiated from the antenna making such angles relative to the earth surface that it advances towards the sky and contribute a great deal to long distance communication.

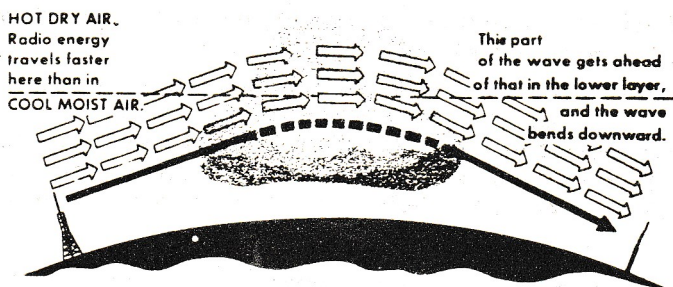
**Q.13. What are the different mode of propagation when radio wave leaves the aerial?**

- (i) Vertical radiation
- (ii) Sky wave radiation
- (iii) Direct parallel wave
- (iv) Ground reflected wave
- (v) Ground wave.

**Q.14 What are the limiting factors of ground wave propagation?**

Poor conductivity, dry, sandy soil tends to attenuate earth current, limiting the range of communication. Most useful frequency for ground wave propagation is upto 3 MHz.

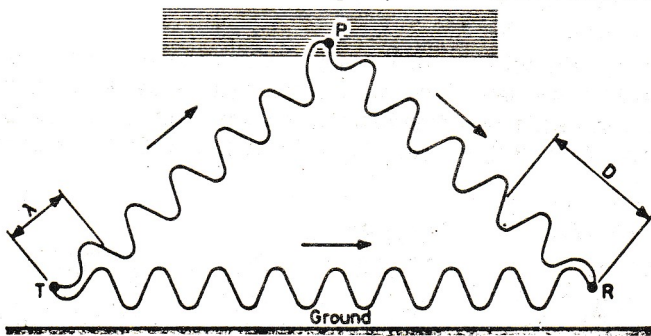




Temperature Inversion phenomenon in case of VHF propagation

**Q.15. What are the two phenomenon significant in line-of-sight reception?**

In case of line of sight reception, there are two components of the signal. One is the direct signal and other is the signal reflected from ionosphere. Both the signals leave the antenna with the same signal phase, but travel different paths



to the receiving antenna. These paths may be of different length. Because the reflected signal suffers 180 degree phase reversal at the point of reflection, the two signals may aid or oppose each other in the receiving antenna. The resultant signal may be stronger or weaker than the direct path signal alone.

**Q.16 How can you overcome the problem caused by this phase reversal phenomenon?**

By varying the height of the antenna, we can improve a weakened signal situation.

**Q.17. What is temperature inversion phenomenon as applicable to line-of-sight communication?**

The line-of-sight propagation is limited to the optical horizon and it is only about 75 miles for frequencies about 30 MHz; but it is found that in the spring or fall, or sometimes in summer, this line-of-sight propagation extends to about 500 miles. This is due to presence of layer of hot, dry air above a layer of cool, moist air. The direct waves are bent back which otherwise pass over the receiving antenna.

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## RADIO RECEIVERS

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**Q.18 : Draw the block diagram of a superheterodyne receiver and explain the function of each stage briefly.**

**Radio Frequency (RF) Amplifier section :**

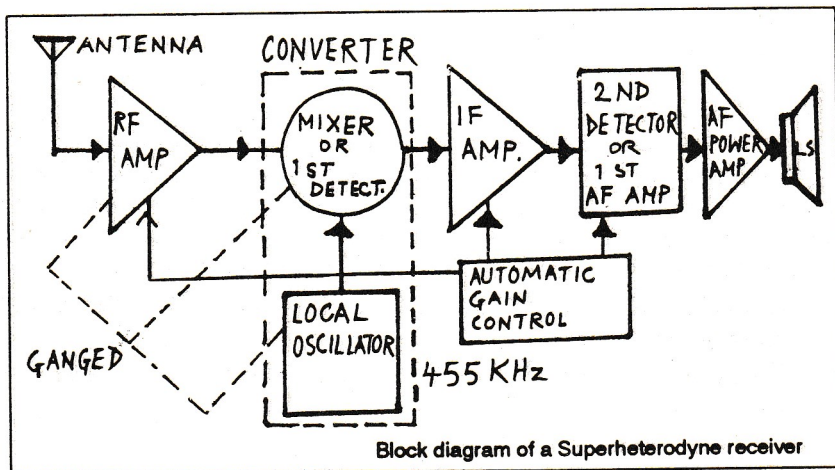
This RF section performs two major tasks :-

- (i) it couples the antenna voltage to the converter of the receiver;
- (ii) By selectivity it accepts only the desired frequency and all others are rejected.

(iii) By amplifying the desired signal, the Signal-to-Noise ratio is increased in the converter stage for efficient operation.

**Converter or Mixer Section :**

Since main objective of the superheterodyne receiver is to produce a Constant Intermediate Frequency (most commonly used frequency being 455 KHz in commercial broadcastband radio sets) which is suitable for-(i) gaining efficiency of the electronic circuitry so far as its amplification is concerned;



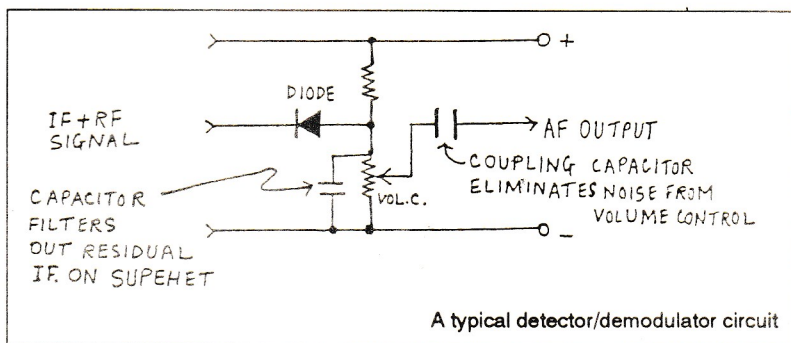


(ii) providing uniform Selectivity;

(iii) providing uniform sensitivity;

So a Local Oscillator and a Mixer circuit are combined, where, by the process of 'Heterodyning', i.e. 'beating', the intermediate frequency is obtained.

Say, the RF Amplifier section selects and amplifies a signal of 800 KHz, then



the local oscillator produces a frequency of 1255 KHz. By mixing both the frequency at the mixer stage, a difference of frequency of the value 455 KHz, is obtained.

i.e. Local oscillator frequency - incoming radio frequency = Intermediate frequency is obtained.

#### Intermediate frequency (IF) Amplifier :

The 455 KHz IF is fed to the IF amplifier through an IF transformer. The IF section circuitry is so designed and so tuned that it gives the optimum gain at that particular IF frequency.

#### Detector / demodulator and 1st Audio Frequency/ AF Amplifier stage :

The Amplitude Modulated (AM) IF is demodulated and detected. A diode working as rectifier solves this purpose. The triode / transistor amplifies the audio signal and the volume control potentiometer system controls the intensity of sound.

**AF Power amplifier :** This section further amplifies the audio signals which is finally fed to an output transformer which matches the impedance of output stage with the speaker (however in modern transistor receivers the necessity of output transformer is eliminated).

### Q.19. Compare and contrast Tuned Radio Frequency-TRF receiver with a Superheterodyne receiver.

(1) A TRF-radio receiver consists of the following stages:

(ii) Antenna input stage

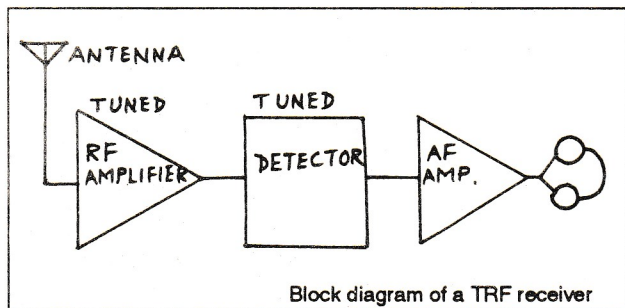
(iii) A few stages for RF-amplification

(iii) A detector stage for demodulation

(iv) One or more stages of AF amplifier

On the other hand a superhet Receiver consists of the :

- (i) RF amplifier
- (ii) Mixer or converter
- (iii) Local oscillator
- (iv) IF amplifier
- (v) Detector
- (vi) Automatic Gain Control-AGC Circuit
- (vii) AF amplifiers



(2) In a TRF receiver a series of loosely coupled tuned circuits are used to increase selectivity and each circuit are ganged so that they resonate at the same frequency.

In superhet RX, this principle is not followed, instead the RF-amplifier, mixer and local oscillator are ganged to produce an intermediate frequency. If  $F_2$  is the local oscillator frequency and  $F_1$  is the incoming broadcast band frequency, then Intermediate frequency, If  $F_{lo}$  is the Local Oscillator Frequency and  $F_{ic}$  is the incoming Broadcast Band Frequency, then Intermediate Frequency,  $F_{if} = F_{lo} - F_{ic}$

(3) In a TRF receiver the high amplitude original frequency is demodulated at the detector stage.

But in Superhet sets, the IF is demodulated.

(4) In TRF RX, no image frequency is produced; image frequency is produced in superhet receiver.

(5) In a TRF receiver, Selectivity is not constant; the receiver is more selective at the low frequency bands, while less selective at the high frequency end.

Since the detector and amplifiers of a superheterodyne receiver can be designed to amplify only the Intermediate Frequency-IF, this receiver can be designed to amplify only the Intermediate Frequency-IF, this receiver is more selective and offer high fidelity (exact reproduction/quality reproduction of the transmitted signal)

(6) In TRF receiver, amplification is not constant over the tuning range.

In superhet receiver amplification standard is constant since all the time it amplifies a constant frequency at the IF stages.



**Q. 20. How the RF amplifier, local oscillator and mixer circuit always maintains a constant frequency separation and why?**

The main objective of the superheterodyne receiver is to produce an intermediate frequency (IF) by the process of heterodyning or beating.

This can be accomplished when two frequencies are mixed to produce the beat frequency. In superhets the IF is usually 455 KHz which is selected because the Broadcastband (BC band) begins above that frequency (observe the dial of your radio set) So, when the RF amplifier is tuned to receive a 800 KHz broadcast signal, the local oscillator must be tuned to 1255 KHz, since the difference frequency, i.e.  $1255-800=455$  KHz in the IF used in the rest of the circuitry.

Now, since we have to tune the RF amplifier section throughout the entire broadcast band, the frequency of the local oscillator must also vary in a manner that it always maintains separation frequency of 455 KHz; to achieve this condition, the Local Oscillator and RF amplifier section is 'ganged', i.e. their tuning condensers are connected/ganged mechanically; when we tune the variable capacitor in the RF section; the variable capacitor in the local oscillator also changes its value, it 'tracks' the 'Aerial Circuit' tuning remaining separated from the tuned frequency by 455 KHz up, i.e. when we tune the RF amp to a 1600 KHz station, the local oscillator frequency becomes 2055 KHz, hence  $IF=2055-1600=455$  KHz.

The Intermediate Frequency (IF), which is a considerably low frequency is being used, being used, because-

- (i) it is a suitable frequency for amplifying efficiency
- (ii) better selectivity.
- (iii) better sensitivity through out the broadcast band and uniform selectivity and uniform sensitivity is maintained.

**Q.21. Write a short note on 'Selectivity'.**

Selectivity is the measure of the ability of a radio receiver to select a particular frequency or particular band of frequencies and rejecting all other unwanted frequencies.

But higher selectivity does not necessarily make a better receiver. For instance a 'broadcast signal' consists of carrier frequency and its two sidebands. That is 800 KHz carrier frequency wave has the following frequency components when modulated with a 5 KHz (5000Hz) audio tone; (i) the carrier frequency, that is 800 KHz; (ii) upper sideband or sum of carrier and audio frequency, i.e. 805 KHz;

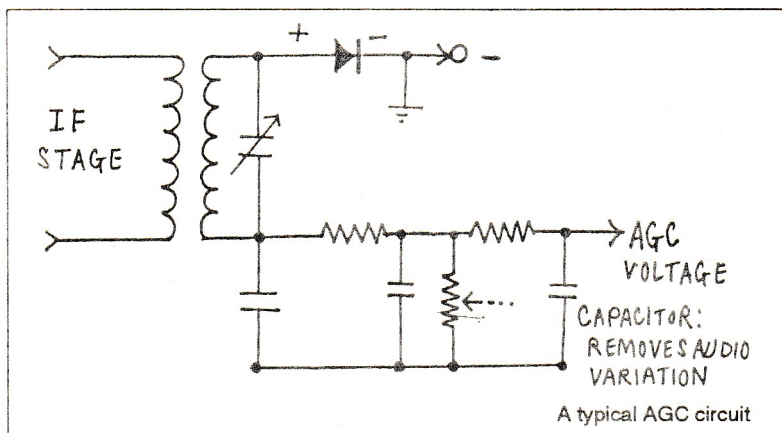
(iii) Lower Side Band (LSB) or difference of carrier and audio frequency, i. e. 795 KHz.

So for proper reproduction of the broadcast signal at a particular carrier frequency, the receiver must receive (select) frequencies from 795 to 805 KHz. A receiver more selective than this would reject a part of the frequencies thus proper reproduction would be hindered.

**Q.22. Write a note on AGC or AVC in a superhet set.**

**AGC-Automatic Gain Control** is a most needed part of the superhet circuitry. A disadvantage of manual gain control (volume control) with a receiver is that it can't provide constant output under all conditions. If a receiver is tuned from a weak signal to strong signal, its output must increase intolerably. This would then require readjustment of the volume control. Similarly, when a receiver is tuned to particular signal the output level can vary widely if the input signal strength fluctuates as a result of fading and adjustments of the volume control has to be done. Since such signal fluctuations are rapid, constant readjustment of volume control would be necessary which is impractical. This is where AGC or AVC comes into the picture and is used in addition to the manual control.

All AGC or AVC (Automatic Volume Control) circuits perform two basic functions;



(i) The first of these is to develop a DC (Direct Voltage) which is proportional to the receiver input signal all the time.

(ii) The AGC voltage is applied to the RF and IF stages of the receiver where it serves as a Bias voltage.

In this way the AGC voltage controls the gain of RF and IF stages, and therefore the overall gain of the receiver. When the signal level at the receiver input increases, the AGC voltage increases proportionately. Consequently, a larger bias is applied to the IF and RF stages and their gain is reduced.

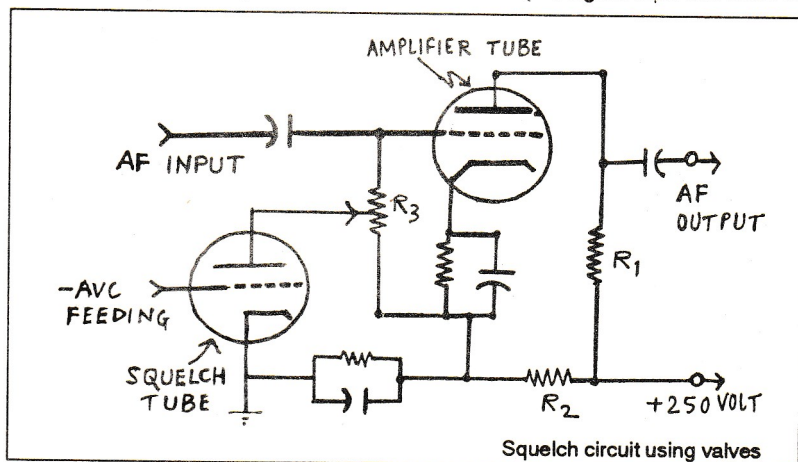
The receiver output thus remains relatively constant instead of increasing in accordance with the input signal strength and vice-versa.

In valve type RX (receiver), the grids of RF and IF portions valves are biased by negative voltage. While in a transistor it depends on transistor type.



### Q.23 What is a squelch circuit?

The squelch or Q (Quieting) circuit is a circuit which is controlled by AGC or AVC voltage. The modern high gain receivers shows a disadvantage without it, that is without a squelch circuit annoying buzzing and crackling sounds are heard over the loudspeaker in absence of input signal. So a circuitry is arranged in such a way that AF gain is kept reduced in absence of input signal from the antenna.



With no signal there is no Negative AGC voltage, and the squelch tube allows current to flow through it then passing through  $R_3$  to the +250 V point. Thus  $R_3$  produces a DC voltage drop across it, more negative at midpoint than at the bottom being in series with the amplifier grid circuit, tube past cutoff, preventing it from functioning.

When a signal is received, AGC or AVC voltage biases the squelch tube to 'Cutoff', stopping plate current flow, consequently, the voltage drop across  $R_3$  ceases, allowing the AF amplifier tube to act in a normal manner.

### Q.24. Write a note on Image frequency in a superhet set?

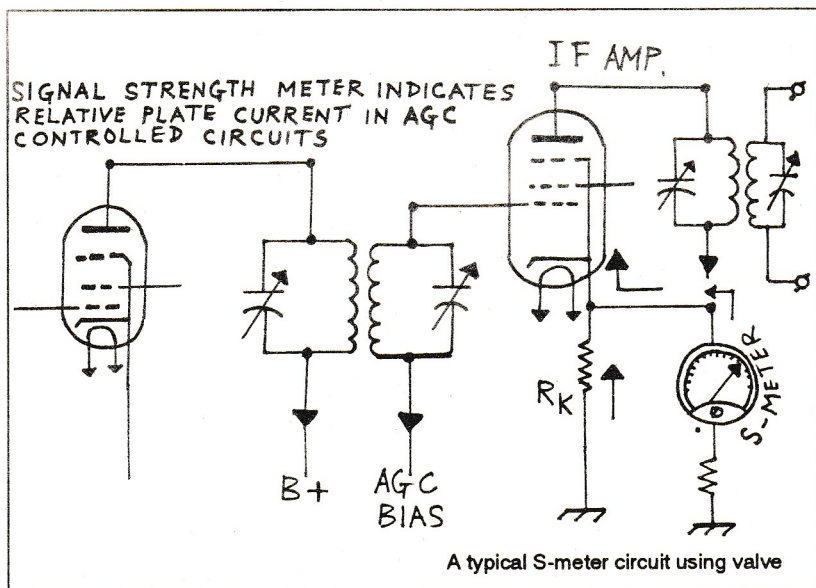
As we know that in a superheterodyne Rx, in intermediate stage (mixer+local oscillator) the 'difference frequency' produced due to beating of RF input frequency and Local oscillator frequency i.e. (Local Oscillator Frequency-Radio Frequency from RF tuned circuit=IF); so to produce IF of 455 KHz at 800 KHz RF tuned circuit, broadcast signal, 1255 KHz is the local oscillator frequency; so  $1255-800=455$  KHz is the IF; but it is found in case of comparatively less selectivity receiver that if a broadcast frequency 455 KHz up, from the 1255 KHz local oscillator frequency manages to intrude the RF tuned circuit to even a little extent, then another difference of frequency equal to Intermediate frequency result; i.e.  $1710-1255=455$  KHz. This 455 KHz since generated from a signal frequency having different audio information causes adverse effect at the audio end of the receiver.

Since the intelligence of both would be present in the speaker at the same time sound reproduction is unintelligible.

**Prevention of image frequency:** (i) By highly selective RF tuned amplifier; (ii) Using an IF which is convenient to use and at the same time separation between desired and image signals is made large. Possibility of image frequency generation is greater in a receiver designed for 175 KHZ IF than a receiver using 455 KHZ. IF.

**Q.25. What is a S-meter?**

**A S-meter** is a visual indicator of signal strength. A simple S meter consists of a milliammeter in series with an RF or IF amplifier plate/ collector circuit.



With no signal, there is no AGC bias voltage and maximum plate current flows.

With a signal, the AGC biases the tube, reducing the plate current and the indication on the meter. The stronger the signal, the less current the meter indicator signifying a strong signal strength.

**Q. 26. What is a BFO?**

To change the second detector from a rectifying or envelope detector to a heterodyne detector to receive A1A (Continuous Wave Morse Code), A2A (Modulated CW Morse Code), J3E (Single Side Band), the Beat-Frequency Oscillator is turned on. It is a variable frequency oscillator using a Hartley, Colpitts, or Armstrong circuit. It is tunable to the IF and one or two kilohertz higher and lower. It heterodynes with any signal coming through the IF strip, producing an audible beat frequency in the detector. Both the BFO and LO (Local Oscillator) must have good frequency stability.



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## TRANSMITTERS

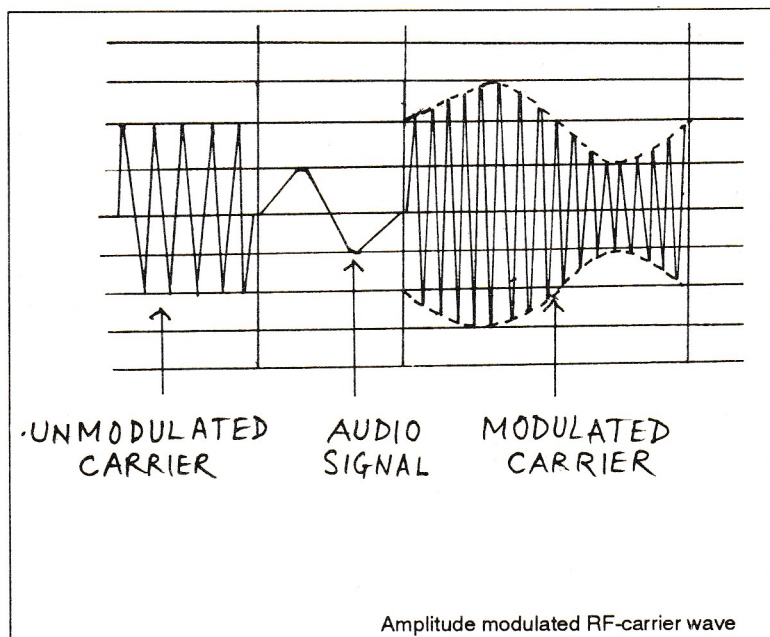
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### Q. 27. What are the Side-bands?

Side bands are the sum and difference frequencies produced at the transmitter by the modulating frequencies. For instance a 5 KHz (5,000 Hz) Audio tone might be used to modulate an 800 KHz carrier frequency. This would produce frequencies of 800 KHz, 805 KHz and 795 KHz are the side band frequencies.

### Q.28. Write what you know about Amplitude Modulation, % ge of Modulation?

Amplitude modulation is a process in which the amplitude of a radio frequency current is made to vary, modify by impressing an audio frequency current on it.



A radio frequency current has a constant amplitude in absence of modulation and this constant amplitude RF carries no information, i.e. no audio intelligence and is of no use to radio telephone (Voice communication), but has application in morse code communication.

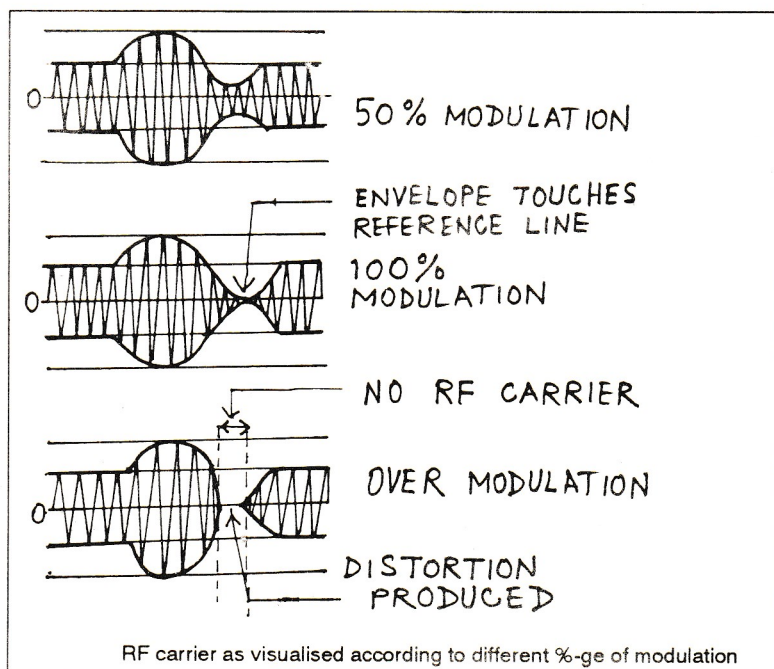
So, to give intelligence to the RF current, audio signal is impressed/ superimposed on the RF current in a non-linear modulator circuit; as a result of which carrier current amplitude begins to rise to a maximum value above and

below its original amplitude during the positive cycle of the audio signal and during the negative cycle of the audio signal it falls to a minimum value.

This results in the carrier having two outlines of the audio signal, this is because the variation at instant in the amplitude of the carrier wave is directly proportional to the value of the modulating signal.

During amplitude modulation two side band frequencies are also produced. Upper sideband frequencies equal to the carrier frequency plus audio frequency and lower side band frequency is equal to carrier frequency minus audio frequency. So the amplitude modulated carrier occupies a space in frequency spectrum, the width of which is equal to twice the highest modulating frequency.

**Percentage of modulation:** The degree of modulation in an AM wave is expressed by % ge of maximum deviation from the normal amplitude of the carrier RF wave.



The effect of such modulated wave is measured by a receiver's ability to reproduce the signal in distorted or undistorted manner.

Percentage of modulation

$$= \frac{\text{Voltage}_{\text{Max}} - \text{Voltage}_{\text{Min}}}{\text{Voltage}_{\text{Max}} + \text{Voltage}_{\text{Min}}} \times 100$$

Where Voltage<sub>Max</sub> is the maximum instantaneous value of the modulation and Voltage<sub>Min</sub> is the minimum value of the RF carrier.

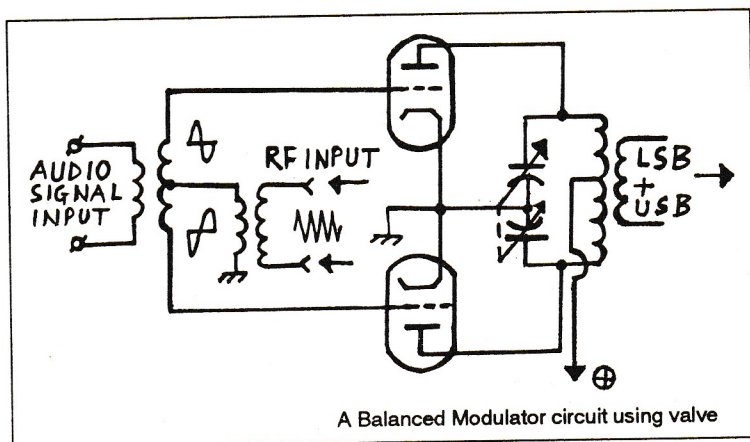


### Q.29. Why over modulation is not desirable?

Over modulation is not desirable i.e. the modulation should not exceed 100%, because if modulation exceeds 100%, there is an interval during the audio cycle when the RF carrier is removed completely from the air thus producing distortion in the transmission.

### Q.30. Write what you know about Single Side Band- (SSB) transmission.

At full modulation the carrier in an AM signal requires two thirds of the power but conveys no information. The second sideband can be viewed as redundant (overlooking frequency-selective fading in an ionospheric transmission path, that may distort one side band at times). Interference between several carrier frequencies, resulting in steady audio whistles or 'beat's is another disadvantage of AM.



Power may be saved and the band occupied by an AM signal in the frequency spectrum can be halved if only one sideband is transmitted without carrier. The result is single-side-band suppressed carrier signal, called simply single side band signal (SSB) transmission.

The carrier must be reintroduced at the receiver in such systems and closely adjusted to the original carrier frequency to avoid signal distortion. The introduced carrier must be within 10 or 20 Hertz of the original carrier frequency for adequate intelligibility of voice signals, and stable oscillators are needed for generation of the local carrier.

For SSB the transmitter does not need to generate carrier power, and ratings are in terms of peak-envelope-power (PEP), the power capability at the peak of the modulating signal with linearity of the amplifier maintained. For equal information content, and 100% modulation, the SSB signal will require only 1/6th power of the double sideband signal. However the situation is even more favourable to SSB when speech is transmitted. Speech is not a continuous sine

wave, and its average power is low with respect to its peak requirements. A peak-to-average power ratio of 10:1 is often assumed for speech, and under that condition a Double Side Band (DSB) AM signal would require 1.05 times carrier power, whereas for equal intelligibility the SSB signal would require only 0.05 units of power or 1/21 as much.

Because of the lower power rating, circuit components designed for SSB equipment can be smaller and lower in cost.

For generation of a modulated signal without carrier, a balanced modulator is used. A filter then discards one side band.

### **Q.31. Why 100% modulation should be aimed in voice transmission?**

The power of a modulated wave is found from the formula:

$$P_{\text{mod}} = (1 + m^2 / 2) \times P_{\text{carr}},$$

where  $P_{\text{mod}}$  = power of the modulated wave,

$m$  = degree of modulation,  $P_{\text{carr}}$  = power in the carrier frequency.

The power in an amplitude modulated wave is divided between the carrier and the two sidebands. The carrier power is constant, and so, the sideband power is the difference between the carrier power and the total power in the modulated wave. The above formula is to find the power of the modulated wave when carrier is modulated by single sinusoidal tone.

If the carrier power = 50 watts

% of modulation = 100 or 1

degree of modulation = 1

Then the power of the modulated wave,

$$P_{\text{mod}} = (1 + 1^2 / 2) \times 50 = 3/2 \times 50 = 75 \text{ Watts}$$

Since carrier power = 50 watts; the two sidebands have 25 watts in them.

i.e.,  $25/75 \times 100\% = 33.3\%$  of the total power with 100% modulation.

In case of 50% modulation with same carrier power we have,

$$P_{\text{mod}} = (1 + 0.5^2 / 2) \times 50 = 2.25/2 \times 50 = 56.25 \text{ Watts.}$$

Now the sidebands have only 6.25 Watts (since  $56.25 - 50 = 6.25$ )

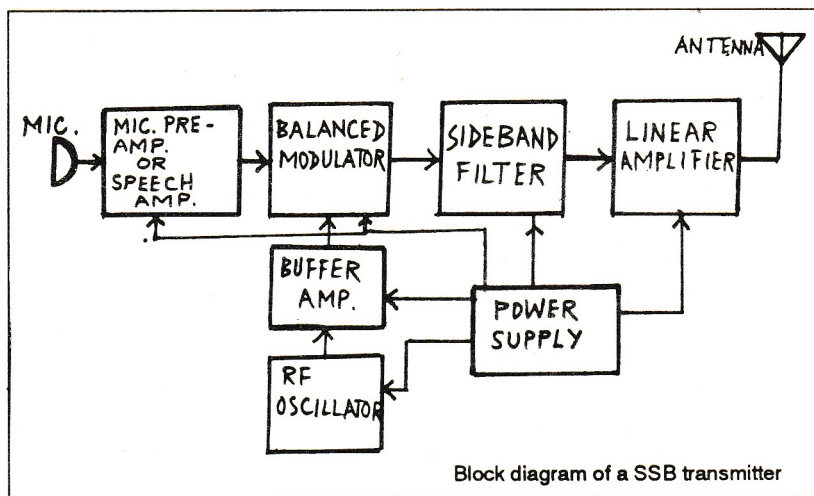
Since all the intelligence being transmitted is contained in the sidebands, the desirability of a high percentage of modulation is crystal clear. A comparatively low powered, but well modulated transmitter often produces a stronger signal at a given point than does a much higher powered, but poorly modulated, transmitted the same distance from the receiver.

### **Q. 32. Draw the schematic diagram of your intended transmitter and explain its function in brief.**

**RF Oscillator :** This is the stage where the carrier frequency intended to be used is generated by means of Crystal-oscillator circuitry or capacitance-inductance variable frequency oscillator (VFO). The RF oscillator is designed to have frequency stability and power delivered from it is of little



importance, hence can be operated with low voltage power supply with little dissipation of heat..



**Buffer amplifier :** The low power RF carrier output from RF oscillator is amplified in this portion and it also keeps the RF oscillator and Power amplifier circuits separate electrically imparting frequency as desired by the amateur can be done in this stage, when the carrier frequency multiplication technique is applied here. In it the morse key for keying out carrier continuous wave can be accommodated.

**Modulator :** Audio information is impressed upon the carrier frequency at this stage.

**Balanced modulator :** In this type of modulator while the audio information (voice) is impressed upon the carrier frequency, at the same time its output gives a signal without carrier frequency but yet with the two side band frequencies carrying the voice/ audio information.

**Side-band filter :** It discards out any one of the sideband.

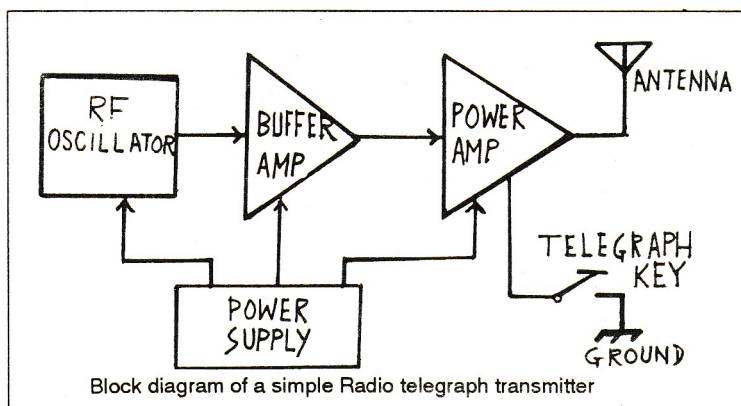
**RF linear amplifier:** RF power amplification is done here and this stage is coupled to the antenna system through antenna impedance matching circuitry. Care is taken at this stage so that no harmonic frequency is generated which will cause interference in adjacent band (splitter) or other bands.

### Q. 35. Why crystal oscillators are used and where ?

Crystal oscillators are used in most modern commercial radio transmitters, either telegraph or telephone. Quartz crystal oscillators are used because they do not drift more than a few hertz from the frequency for which they are ground. A variable frequency oscillator (VFO) tends to drift considerably more.

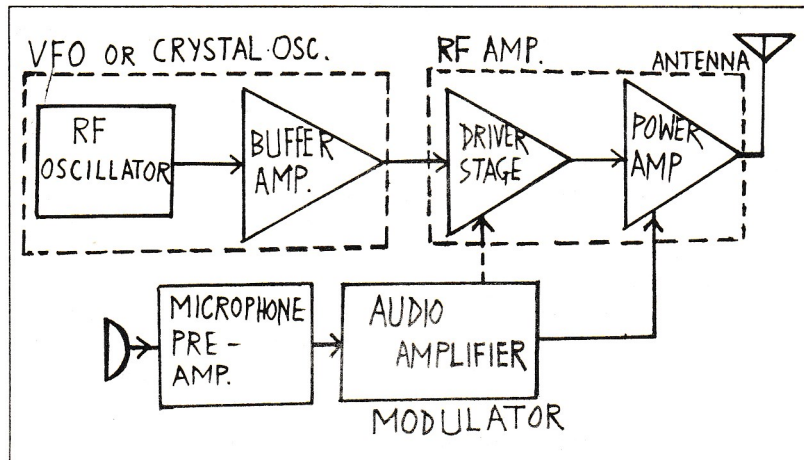
**Q. 34. Draw the block diagram of a Simple radio telegraph transmitter and explain.**

✱ Refer to the answer of Q.32.



**Q. 35. Draw and explain the block diagram of a simple amplitude modulated transmitter.**

✱ Refer to the answer to Q. 32.





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## AC CIRCUITS

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### Q.36. What do you mean by RMS value?

The, RMS, Root Mean Square value is the value of voltage of an AC source (alternating current) which consumes same as by a d.c. voltage. That is, it is the effective value of a sine-wave voltage found from the formula:

$$V_{\text{eff}} = V_{\text{max}} \times 0.707$$

If all the instantaneous values of the half cycle of a sinusoidal current are squared and their mean or average is found, then it will be equal to 0.707 of the instantaneous peak value. It is also called the effective value or RMS value, since this is equivalent to steady D. C. Voltage of same value. In a domestic ac supply, 230 volts is actually the effective voltage,  $V_{\text{eff}}$ ;

Now, let Sine wave voltage,  $V_{\text{max}}=325$  volt.

therefore  $V_{\text{eff}}=325$  volt is equivalent to 230 volt DC. That is it will produce same heat flowing through the same resistor coil that would be produced by  $V_{\text{eff}}$  230 V of D. C.

### Q.37. What is the 'Q' of a circuit?

The term 'Q' is applied to AC circuits in which inductance and capacitance are involved. It infact express is the 'quality' of the inductor or capacitor or capacitor and since lesser the ohmic resistance of the coil, more perfect inductor the coil is, with little loss hence "Q" can be found from the formula:

$Q = X_i/R$  (in case of coil); where  $X_i$  = inductive reactance,  $R$  = Ohmic resistance.

Again,  $X_i = 2 \pi fL$ , where  $f$  = frequency,  $L$ =inductance

Therefore,  $Q=2 \pi fL/R$ ; this shows that same coil/inductor possess high 'Q' at higher frequency.

A phenomenon called "**Skin effect**", also causes a less efficient inductor/coil.

It is found that at higher frequencies, electrons flow nearer to the surface of the conducting wire; since the usable cross- sectional area lessens, the ohmic resistance increases resulting in a lower "Q".

### Q.38. What is Skin effect? How skin effect can be prevented?

\* -(see last part of the answer above)

Prevention of Skin effect :

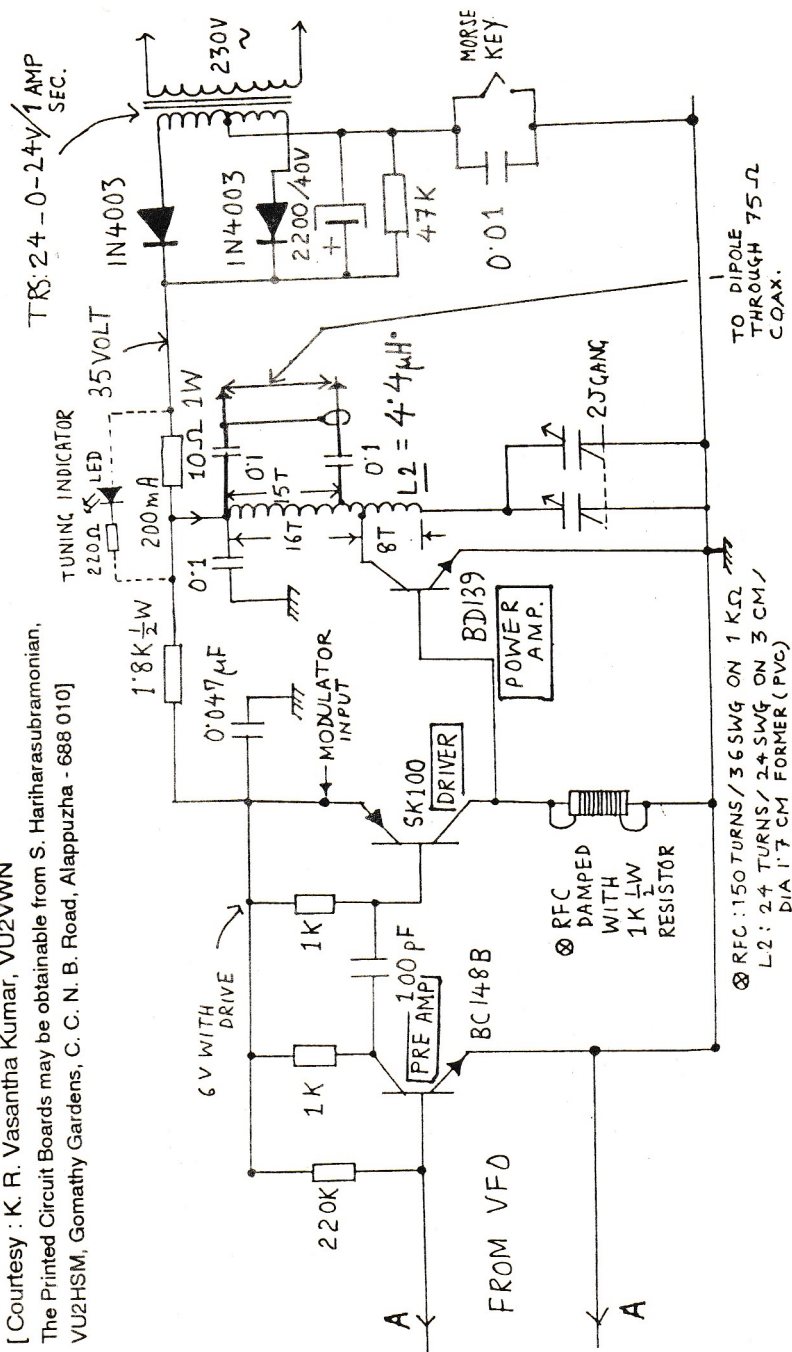
- (i) Using large diameter wire
- (ii) By silver- plating of the wire used;
- (iii) Using fewer turns while making the coil, but increasing the core-permeability; eg using powdered iron core.
- (iv) Using "Litz" wire.

In case of a capacitor,  $Q=X_c/R=1/2\pi fCR$ .

So higher the frequency, lower the Q of the capacitor.

## A practical 7MHz CW QRP Transmitter

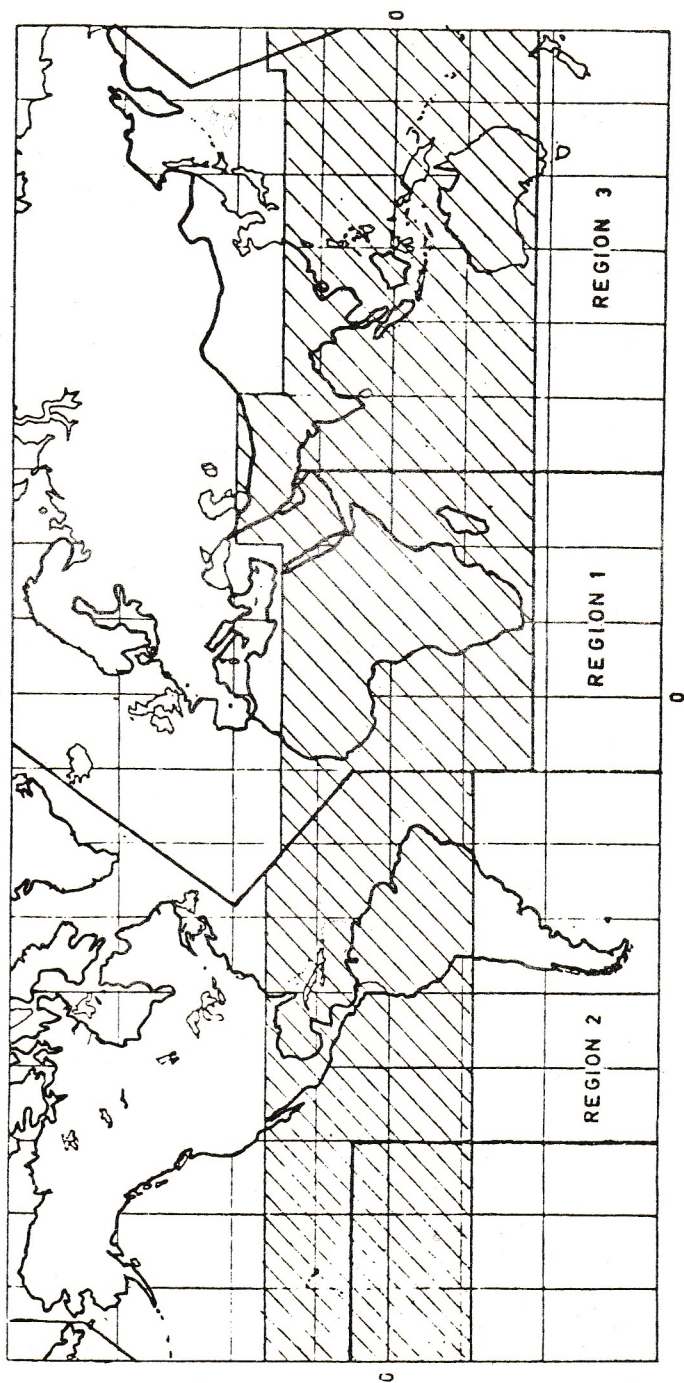
[ Courtesy : K. R. Vasantha Kumar, VU2VWN  
The Printed Circuit Boards may be obtainable from S. Hariharasubramanian,  
VU2HSM, Gomathy Gardens, C. C. N. B. Road, Alappuzha - 688 010]





## Appendix I(c)

THE RADIO REGION MAP



## **APPENDIX II**

### **A MODEL QUESTION PAPER FOR ASOC EXAMINATION**

#### **SECTION A**

1. State whether the following are correct or not :
  - (a) A high pass filter is one which allows frequencies in the middle of a band.
  - (b) Audio amplifiers normally operate on Class C Condition.
  - (c) Centre tapped transformer secondary is essential for a bridge rectifier.
  - (d) In a PNP transistor the collector is applied with a negative voltage.
  - (e) Efficiency of transmission of power is better if standing wave ratio is higher.
  - (f) Crystal controlled oscillators are normally used for more power output at lower stages.
- 2.(a) If the local oscillator of a Superheterodyne receiver is tuned to 7140 KHz and the IF is 455, what are the signal and image frequencies ?  
(b) If a capacitor of value 1 MFD is connected in series with an inductor of 1 mH and a resistance of 10 ohms, what is the effective impedance of a circuit to 200 volt 50 Hz AC Supply?
3. Draw a schematic of the transmitter which you intend to build in your ham activity. Describe briefly the modulator stage of any transmitter.
4. (a) What are the types of transmission lines used for conveying power from transmitter to an aerial?  
(b) Explain the colour code for resistance. How will a resistance 3500 ohms be colour-coded?
5. Write short notes on any three of-
  - (a) Harmonic radiation (b) Fading (c) Hartley oscillator
  - (d) Class C amplifiers (e) Sensitivity of receivers.
6. What is a push pull amplifier and what are its advantage over other amplifiers?

#### **SECTION B**

1. What is a distress signal? What action would you take if you intercept a distress message?
2. Describe the procedure of establishing a contact with another amateur radio station. Is it necessary to listen on the receiver before starting to make a call on a ham transmitter?
3. What are the main functions of an amateur radio station?  
Would you agree to clear a message on behalf of a close friend of yours? If so what it may be called ?



5. Can you use secret language? Why is it necessary to observe secrecy of communication?

6. What are amateur bands of frequencies?

7. Give the meaning of (a) QRM? (b) QSB? (c) QSY 10 KHz up (d) BT (e) QRX 10 minutes (f) QRT?

## APPENDIX III

### SIGNAL REPORT IN TELEPHONY

When on-the-air contact between two amateur radio stations is established, both the stations exchange signal reports. For telephony (voice), Readability and Signal strength scale is devised ;

| Readability Scale |                                           | Signal Strength scale |                                    |
|-------------------|-------------------------------------------|-----------------------|------------------------------------|
| Q1                | Hardly perceptible; unreadable            | R1                    | Unintelligible; barely perceptible |
| Q2                | Weak; readable now and then               | R2                    | Weak signals; barely readable      |
| Q3                | Fairly good; readable but with difficulty | R3                    | Weak signals; but can be copied    |
| Q4                | Good; readable                            | R4                    | Fair signals                       |
| Q5                | Very good; perfectly readable             | R5                    | Fairly good signals                |
|                   |                                           | R6                    | Good signals                       |
|                   |                                           | R7                    | Moderately strong signals          |
|                   |                                           | R8                    | Strong signals                     |
|                   |                                           | R9                    | Extremely strong signals           |

### SIGNAL REPORTING IN TELEGRAPHY (MORSE)

In radio telegraphy contact using morse code the RST system of reporting is followed which was devised by W2BSR of New York.

#### THE RST SYSTEM

##### Readability

1. Unreadable
2. barely readable, occasional words distinguishable
3. readable with considerable difficulty
4. Readable with practically no difficulty
5. Perfectly readable

### **Signal Strength**

- 1- Faint, signals barely perceptible
- 2- Very weak signals
- 3- Weak signals
- 4- Fair signals
- 5- Fairly good signals
- 6- Good signals
- 7- Moderately strong signals
- 8- Strong signals
- 9- Extremely strong signals

### **Tone**

- 1- Extremely rough hissing note
- 2- Very rough AC note, no trace of musicality
- 3- Rough, low-pitched AC note, slightly musical
- 4- Rather rough AC note, moderately musical.
- 5- Musically modulated note
- 6- Modulated note, slight trace of whistle.
- 7- Near DC note, smooth ripple
- 8- Good DC note, just trace of ripple
- 9- Purest DC note.

## **APPENDIX IV**

### **THE 'Q' CODES USED BY AMATEUR RADIO STATIONS**

|      |                                                            |
|------|------------------------------------------------------------|
| QRA? | What is the name of your station?                          |
| QRG? | What is your exact frequency?                              |
| QRI? | How is the tone of my transmission?                        |
| QRK? | What is the readability of my signal?                      |
| QRL? | Are you busy?                                              |
| QRM? | Are you being interfered with?                             |
| QRN? | Are you being troubled by static?                          |
| QRQ? | Shall I send faster?                                       |
| QRS? | Shall I send slowly?                                       |
| QRT? | Are you going to close down?                               |
| QRU? | Have you any-thing for me?                                 |
| QRV? | Are you ready?                                             |
| QRW? | Shall I inform ..... that you are calling him on .... MHz? |
| QRX? | When will you call me again?                               |
| QRZ? | Who is calling me?                                         |
| QSA? | What is my signal strength?                                |



|      |                                                                         |
|------|-------------------------------------------------------------------------|
| QSB? | Are my signals fading?                                                  |
| QSL? | Can you acknowledge receipt?                                            |
| QSO? | Can you communicate with ..... direct or by relay?                      |
| QSU? | Shall I send or reply on this frequency (or on ..... MHz by, ... mode)? |
| QSV? | Shall I send a series of 'V'?                                           |
| QSW? | Will you send on .... MHz by .... mode?                                 |
| QSX? | Will you listen to..... on..... MHz?                                    |
| QSY? | Shall I change my frequency?                                            |
| QTC? | How many telegrams have you to send?                                    |
| QTH? | What is your location?                                                  |
| QUM? | Is the distress traffic ended?                                          |

## APPENDIX V

### RADIO TELEGRAPHY CALLING PROCEDURE

Once you get your licence and the callsign, it is time for you to start transmission; When you use morse code the following procedures should be followed:

(i) When you want to give a general call, that is, you want to make a contact with any station from any part of the world, then CQ call is given; the format looks like:

CQ CQ CQ DE VU2ABC VU2ABC AR K

Here CQ=General call or attention all stations;

DE=This is AR=End of message and K=Invitation to transmit.

(ii) If a station responds to your call you may hear it as;

VU2ABC VU2ABC VU2ABC DE 4S7VK KN

here KN= Invitation to transmit addressed to a particular station; in this case the station 4S7VK is responding to your call only.

(iii) Now on hearing him, you send a message in similar format but not followed by KN, instead you use separation indicator BT and continue with your message to him

It may look like:

4S7VK DE VU2ABC BT

TNX FER CALLING ME BT UR RST RST IS 579

BT MY NAME IS XYZ

ES QTH IS XYZ BT OK? BT 4S7VK DE VU2ABC KN

Here TNX= Thanks FER=For QTH=location ES=and

BT=Separation mark to separate each sentence.

## RADIO TELEPHONY CALLING PROCEDURE

Phone procedure, no less than morse code (CW), is aimed at keeping listening stations fully informed of what is going on the band. However due to use of plain language, the techniques are rather simpler. Perhaps the main thing is to remember that you are using spoken word. The undue use of morse code (CW) abbreviations not only sounds ridiculous, it even wastes time.

In voice communication, when you want to make a general call, give a CQ call for a short while (not more than three times) followed by the stations callsign distinctly three or four times using phonetics.

## PHONETICS USED BY RADIO AMATEURS

|            |                    |
|------------|--------------------|
| A- Alpha   | N- November/Nancy  |
| B- Bravo   | O- Oscar           |
| C- Charlie | P- Papa            |
| D- Delta   | Q- Quebec          |
| E- Echo    | R- Romeo           |
| F- Foxtrot | S- Sierra          |
| G- Golf    | T- Tango           |
| H- Hotel   | U- Uniform/United. |
| I- India   | V- Victor          |
| J- Juliet  | W- Whisky          |
| K- Kilo    | X- X-ray           |
| L- Lima    | Y- Yankee          |
| M- Mike    | Z- Zulu            |

## ABBREVIATIONS USED IN RADIO TELEGRAPHY

|      |                         |       |                    |
|------|-------------------------|-------|--------------------|
| AA   | Artificial antenna      | CANS  | Headphones         |
| ABT. | About                   | CKT   | Circuit            |
| AGN  | Again                   | CLG   | Calling            |
| ANI  | Any                     | CO    | Crystal oscillator |
| ANT  | Antenna                 | CPSE  | Counterpoise       |
| BC   | Broadcast               | CQ    | General call       |
| FB   | Fine business           | CONDX | Conditions         |
| BCL  | Broadcast band listener | CU    | See you            |
| BCNU | Be seeing you           | CUL   | See you later      |
| BK   | Break                   | DF    | Direction finding  |
| CK   | Check                   |       |                    |



|      |                                    |             |                                                                                                                      |
|------|------------------------------------|-------------|----------------------------------------------------------------------------------------------------------------------|
| DX   | Distant (Long distance reception)  | RCVR        | Receiver                                                                                                             |
| ECO  | Electron coupled oscillator        | RPRT        | Report                                                                                                               |
| ERE  | Here                               | RPT         | Repeat                                                                                                               |
| ES   | And                                | RX          | Receiver                                                                                                             |
| FB   | Fine business                      | SA          | Say                                                                                                                  |
| Fer  | For                                | SED         | Said                                                                                                                 |
| FR   | For                                | SIGS        | Signals                                                                                                              |
| FONE | Telephony                          | SWL         | Short wave Listener                                                                                                  |
| GA   | Go ahead/Good afternoon.           | TKS         | Thanks                                                                                                               |
| GE   | Good evening                       | TNX         | Thanks                                                                                                               |
| GM   | Good Morning                       | TX          | Transmitter                                                                                                          |
| GLD  | Glad                               | U           | You                                                                                                                  |
| GND  | Ground                             | UR          | Your/You are                                                                                                         |
| GUD  | Good                               | VA          | End of work                                                                                                          |
| HI   | Laughter                           | VY          | Very                                                                                                                 |
| HPE  | Hope                               | WX          | Weather                                                                                                              |
| HR   | Here/hear                          | WID         | With                                                                                                                 |
| HRD  | Heard                              | WKD         | Worked                                                                                                               |
| HV   | Have                               | WL          | Will                                                                                                                 |
| KCS  | Kilocycles                         | WUD         | Would                                                                                                                |
| LID  | Bad operator                       | XMTR        | Transmitter                                                                                                          |
| MNI  | Many                               | XTAL        | Crystal                                                                                                              |
| MO   | Master oscillator                  | XYL         | Wife                                                                                                                 |
| MCS  | Megacycles                         | YF          | Wife                                                                                                                 |
| ND   | Nothing doing                      | YL          | Young lady                                                                                                           |
| NW   | Now                                |             | (lady amateur)                                                                                                       |
| OB   | Old boy (Young radio amateur)      | 73          | Best regards                                                                                                         |
| OM   | Old man (amateur who is not a boy) | 88          | Love and kisses                                                                                                      |
| OP   | Operator                           | HARMONIC :  |                                                                                                                      |
| OT   | Old timer                          |             | The son or daughter of the radio operator (Just as the harmonic frequency generated out of a fundamental frequency!) |
| PA   | Power amp                          | BARE FOOT : |                                                                                                                      |
| PSE  | Please                             |             | A transmitter running without an external linear amplifier.                                                          |
| PX   | Press                              |             |                                                                                                                      |
| QRP  | Very low power                     |             |                                                                                                                      |
| QSL  | Received OK                        |             |                                                                                                                      |
| R    | All received correctly             |             |                                                                                                                      |
| RCVD | Received                           |             |                                                                                                                      |

## APPENDIX VI

### DISTRESS, URGENCY AND SAFETY CODES

**Distress Signal :** The radio telephone distress signal consists of the word **"MAYDAY"** pronounced as the French expression 'm' alder'.

The radio telegraph distress signal consists of the group ... --- ... symbolized herein by **SOS** and transmitted as single signal in which the dashes are emphasized so as to be distinguished clearly from the dots.

Distress signal indicate that a ship, aircraft or other vehicle is threatened by grave and imminent danger and requests immediate assistance. **The distress call has absolute priority over all other transmissions.**

**Urgency Signal :** In radio telegraphy the urgency signal consists of three repetitions of the group **XXX**, sent with the letters of each group and the successive groups clearly separated from each other.

In telephony, the urgency signal consists of three repetitions of the group of words **'PAN PAN'** each word of the group pronounced as the French word **"panne"**. The urgency signal is transmitted before the call thus indicating that the calling station has a very urgent message to transmit concerning the safety of a ship, aircraft or other vehicle or the safety of a person. **The urgency signal has priority over all other transmission except distress call.**

**Safety signal :** It consists of the three repetitions of the group **TTT** sent with the letters of each group and the successive groups clearly separated from each other.

In telephony, it consists of three repetitions of the word **'Security'** and pronounced as **"Say-cure-ity"**. It announces that the station is about to transmit a message concerning the safety or navigation or giving important meteorological warning.

## APPENDIX VII

### AMATEUR RADIO PREFIXES AND ZONES

The amateur radio zoning system was originated in 1938 by "Radio Magazines Incorporate" of New York which is accepted by the amateur radio stations worldwide. Some of them are given below.

| PREFIX | ZONE | COUNTRY              |
|--------|------|----------------------|
| AP     | 22   | PAKISTAN             |
| A3     | 32   | TONGO                |
| A4     | 21   | SULTANATE OF OMAN    |
| A5     | 22   | BHUTAN               |
| A6     | 21   | UNITED ARAB EMIRATES |



|          |       |                                                                              |
|----------|-------|------------------------------------------------------------------------------|
| A7       | 21    | QATAR                                                                        |
| A9       | 21    | BAHRAIN                                                                      |
| BV       | 24    | TAIWAN                                                                       |
| BY       | 23,24 | CHINA                                                                        |
| CE       | 12    | CHILE                                                                        |
| CE9AA-AM |       | CHILEAN ANTARCTIC, TIERRA DE<br>O'HIGGINS, PALMER PENINSULA,<br>GRAHAM LAND. |
| CE9AN-AZ | 13    | SOUTH SHETLAND ISLAND                                                        |
| CEφA     | 12    | EASTER ISLAND                                                                |
| CEφX     | 12    | SAN FELIX ISLAND                                                             |
| CEφZ     | 12    | JUAN FERNANDEZ IS. (ARCHIPELAGO)                                             |
| CM,CO    | 8     | CUBA                                                                         |
| CN       | 33    | MOROCCO                                                                      |
| CP       | 10    | BOLIVIA                                                                      |
| CR3      | 35    | GUINEA BISSAU                                                                |
| CR9      | 24    | MACAO                                                                        |
| CT       | 14    | PORTUGAL                                                                     |
| CT2      | 14    | AZORES ISLAND                                                                |
| CT3      | 33    | MADEIRA ISLAND                                                               |
| CX       | 13    | URUGUAY                                                                      |
| C2       | 31    | NAURA                                                                        |
| C3       | 14    | ANDORRA                                                                      |
| C5       | 35    | GAMBIA                                                                       |
| C6       | 8     | BAHAMA ISLAND                                                                |
| C8,C9    | 37    | MOZAMBAIQUE                                                                  |
| DA,DL    | 14    | WEST GERMANY                                                                 |
| DM       | 14    | EAST GERMANY                                                                 |
| DU       | 27    | PHILIPPINS                                                                   |
| D2       | 36    | ANGOLA                                                                       |
| D4       | 35    | CAPE VERDE ISLANDS                                                           |
| D6       | 39    | STATE OF COMORO/COMORO IS.                                                   |
| EA       | 14    | SPAIN                                                                        |
| EA6      | 14    | BALEARIC ISLANDS                                                             |
| EA8      | 33    | CANARY ISLANDS                                                               |
| EA9      | 33    | CEUTA & MELILLA, IFNI,<br>SPANISH SAHARA                                     |
| EI       | 14    | IRELAND (REPUBLIC)                                                           |
| EJφ      |       | ARAN ISLAND                                                                  |
| EL       | 35    | LIBARIA                                                                      |

|        |    |                                                                                                            |
|--------|----|------------------------------------------------------------------------------------------------------------|
| EP/EQ  | 21 | IRAN                                                                                                       |
| ET     | 37 | ETHIOPIA, ERITREA                                                                                          |
| F      | 14 | FRANCE                                                                                                     |
| FB8W   | 39 | CROZET ISLANDS                                                                                             |
| FB8X   | 39 | KERGUELEN ISLANDS                                                                                          |
| FB8Y   |    | FRENCH ANTARCTICA.                                                                                         |
| FC     | 15 | CORSICA                                                                                                    |
| FG/FS  | 8  | GUADELOUPE AND DEPENDENCIES                                                                                |
| FH     |    | MAYOTTE                                                                                                    |
| FK     | 32 | NEW CALEDONIA                                                                                              |
| FM     | 8  | MARTINIQUE                                                                                                 |
| FO     | 7  | FRENCH POLYNESIA, CLIPPERTON ISLANDS                                                                       |
| FP     | 5  | ST. PIERRE & MIQUELON IS.                                                                                  |
| FR     | 39 | REUNION IS, JUGAN DE NOVA,<br>GLORIANO,<br>TROMELIN II.                                                    |
| FS     |    | ST. MARTIN ISLAND                                                                                          |
| FW     | 30 | WALLIS AND FUTUNA ISLAND                                                                                   |
| FY     | 9  | FRENCH GUIANA AND ININI                                                                                    |
| G      | 14 | ENGLAND                                                                                                    |
| GD     | 14 | ISLE OF MAN                                                                                                |
| GI     | 14 | NORTHERN IRELAND                                                                                           |
| GM     | 14 | SCOTLAND                                                                                                   |
| GW     | 14 | WALES                                                                                                      |
| HA     | 15 | HUNGARY                                                                                                    |
| HB     | 14 | SWITZERLAND                                                                                                |
| HBφ    | 14 | LIECHTENSTEIN                                                                                              |
| HC     | 10 | EQUADOR                                                                                                    |
| HC8    | 10 | GALAPAGOS ISLAND                                                                                           |
| HG     | 15 | HUNGARY                                                                                                    |
| HH     | 8  | HAITI                                                                                                      |
| HI     | 8  | COLOMBIA                                                                                                   |
| HKφ    | 7  | ARCH. OF SAN ANDRES &<br>PROVIDENCIA ISLANDS, BAJO NUEVO,<br>MALPELO IS., SERNANA BANK AND<br>RONCARDO CAY |
| HL, HM | 25 | KOREA                                                                                                      |
| HP     | 7  | PANAMA                                                                                                     |
| HR     | 7  | HONDURAS                                                                                                   |
| HRφ    | 7  | SWAN ISLANDS                                                                                               |



|       |       |                                                            |
|-------|-------|------------------------------------------------------------|
| HS    | 26    | THAILAND                                                   |
| HV    | 15    | VATICAN CITY                                               |
| HZ    | 21    | SOUDI ARABIA                                               |
| H4    | 28    | SOLOMON ISLAND                                             |
| I-IZ  | 15    | ITALY                                                      |
| IA    | 15    | TUSCAN ARCHIPELAGO                                         |
| IC    | 15    | CAPRI AND ISCHIA ISLANDS                                   |
| IG    |       | LAMPEDUSA ISLANDS                                          |
| IH    | 33    | PANTELLERIA ISLANDS                                        |
| IM    |       | MADDALENA ISLANDS                                          |
| IS    | 15    | SARDINIA                                                   |
| IT    | 15    | SICILY                                                     |
| JA-JS | 25    | JAPAN                                                      |
| JD1   | 25    | OGASAWARA, MINAMI-TORI-SHIMA IS.                           |
| JR6   | 25    | OKINAWA (RYUKYU ISLAND)                                    |
| JT    | 23    | MONGOLIA                                                   |
| JW    | 40    | JAN MAYEN ISLAND                                           |
| JY    | 20    | JORDAN.                                                    |
| J2    | 37    | DJIBOUTI                                                   |
| J3    | 8     | GRENADA                                                    |
| J5    | 35    | GUINEA BISSAN                                              |
| J6L   |       | ST. LUCIA                                                  |
| J7D   | 8     | DOMINICA                                                   |
| K     | 3-5   | UNITED STATES OF AMERICA                                   |
| KA    | 25    | JAPAN (U.S. FORCES)                                        |
| KB6.  | 31    | BAKER, HOWLAND, AM. PHOENIX,<br>CANTON, ENDERBURIY ISLANDS |
| KC4   | 13    | U.S. ANTARCTICA                                            |
| KC4   | 8     | NAVASSA ISLAND                                             |
| KC6   | 27    | EASTERN CAROLINE ISLAND                                    |
| KC6   | 27    | WESTERRN CAROLINE ISLAND                                   |
| KG4   | 8     | GUARNTANAMO BAY                                            |
| KG6   | 27    | GUAM                                                       |
| KG6   | 27    | MARIANA ISLANDS(GUAM), MARCUS IS.                          |
| KH6   | 31    | KURE &HAWALI ISLANDS.                                      |
| KJ6   | 31    | JOHNSTON ISLAND                                            |
| KL7   | 1     | ALASKA                                                     |
| KM6   | 31    | MIDWAY ISLANDS                                             |
| KN    | 3,4,5 | U.S.A. (NOVICES)                                           |
| KP4   | 8     | PUERTO RICO                                                |

|       |       |                                                                                    |
|-------|-------|------------------------------------------------------------------------------------|
| KP6   | 31    | PALMIYRA GROUP, JARVIS ISLANDS                                                     |
| KS6   | 32    | U.S. SAMOA                                                                         |
| KV4   | 8     | VIRGIN ISLANDS (U.S)                                                               |
| KW6   | 31    | WAKE ISLANDS                                                                       |
| KX6   | 31    | MARSHALL ISLANDS                                                                   |
| KZ5   | 7     | PANAMA CANAL ZONE                                                                  |
| LA-LJ | 14    | NORWAY                                                                             |
| LU    | 13    | ARGENTINA                                                                          |
| LU    | 13    | ARGENTINE ANTARCTICA                                                               |
| LX    | 14    | LUXEMBOURG                                                                         |
| LZ    | 20    | BULGARIA                                                                           |
| M1    | 15    | SAN MARINO                                                                         |
| N     | 3,4,5 | U.S.A.                                                                             |
| OA    | 10    | PERU                                                                               |
| OD    | 20    | LEBANON.                                                                           |
| OE    | 15    | AUSTRIA                                                                            |
| OH    | 15    | FINLAND                                                                            |
| OHφ   | 15    | ALAND ARCHIPELIGO                                                                  |
| OK,OL | 15    | CZECHOSLOVAKIA                                                                     |
| ON    | 14    | BELGIUM                                                                            |
| OX    | 40    | GREENLAND                                                                          |
| OY    | 14    | FAROE ISLANDS                                                                      |
| OZ    | 14    | DENMARK                                                                            |
| PA-PI | 14    | NETHERLANDS                                                                        |
| PJ    | 8     | NETHERLANDS ANTILLES (LEEWARD)                                                     |
| PJ    | 9     | NETHERLANDS ANTILLES (WIND WARD)                                                   |
| PP-PY | 11    | BRAZIL                                                                             |
| PYφ   | 11    | TRINDADE ISLANDS, ST. PETER &<br>FERNANDO DE NORONHAS ROCAS IS.,<br>ST. PAUL ROCKS |
| PZ    | 9     | SURINAM                                                                            |
| PZ    |       | PAPUA NEW GUINEA                                                                   |
| SJ-SM | 14    | SWEDEN                                                                             |
| SP    | 15    | POLAND                                                                             |
| ST    | 34    | SUDAN                                                                              |
| SU    | 34    | EGYPT                                                                              |
| SV    | 20    | CRETE, GREECE,                                                                     |
| SV5   | 20    | DODECANESE ISLAND                                                                  |
| S21   | 22    | BANGLADESH                                                                         |
| S7    | 39    | SEYCHELLES ISLANDS                                                                 |



|             |       |                              |
|-------------|-------|------------------------------|
| S8          |       | TRANSKEI                     |
| S9          |       | ST. THOMAS AND PRINCIPE      |
| TA-TC       | 20    | TURKEY                       |
| TF          | 40    | ICELAND                      |
| TG          | 7     | GUATEMALA                    |
| TI          | 7     | COSTA RICE                   |
| TI9         | 7     | COCOS ISLAND                 |
| TJ          | 36    | CAMEROON                     |
| TL          | 36    | CENTRAL AFRICAN REPUBLIC     |
| TN          | 36    | CONGO (REPUBLIC)             |
| TR          | 36    | GABON                        |
| TT          | 36    | CHAD                         |
| TU          | 35    | IVORY COAST                  |
| TY          | 35    | BENIN                        |
| TZ          | 35    | MALI                         |
| TZ          | 28    | TIVALU                       |
| UA1,2,3,4,6 | 16    | EUROPEAN U.S.S.R (ERSTWHILE) |
| UA9,φ       | 17,19 | ASIATIC USSR (DO)            |
| UA 1        | 40    | FRANZ JOSEF LAND             |
| UA 1        |       | RUSSIAN ANTARCTICA           |
| UA 2        | 15    | KALININGRADSK                |
| UB 5, UT5   | 16    | UKRAINE                      |
| UC 2        | 16    | WHITE RUSSIA                 |
| UD 6        | 21    | AZERBAIJAN                   |
| UF 6        | 21    | GEORGIA                      |
| UG 6        | 21    | ARMENIA                      |
| UH 8        | 17    | TURKMEN                      |
| UI 8        | 17    | UZBEK                        |
| UJ 8        | 17    | TADZHIK                      |
| UL 7        | 17    | KAZ AKH                      |
| UM 8        | 17    | KIRGHIZ                      |
| UN 1        |       | KARELO FINNISH               |
| UO 5        | 16    | MOLDAVIA                     |
| UP 2        | 15    | LITHUANIA                    |
| UQ 2        | 15    | LATVIA                       |
| UR 2        | 15    | ESTONIA                      |
| VE          | 1-5   | CANADA                       |
| VK          | 29    | AUSTRALIA                    |
| VK 2        | 30    | LORD HOWE ISLAND             |
| VK 9N       | 29    | NARFOLK ISLAND               |

|           |          |                                                                  |
|-----------|----------|------------------------------------------------------------------|
| VK 9X     | 29       | CHRISTMAS ISLAND                                                 |
| VK 9Y     | 29       | COCOS KEELING ISLANDS                                            |
| VK 9Z     | 30       | WILLIS ISLAND                                                    |
| VK $\phi$ | 29,30,39 | AUSTRALIAN ANTARCTICA                                            |
| VK $\phi$ | 39       | HEARD ISLAND                                                     |
| VK $\phi$ | 30       | MACQUARIE ISLANDS                                                |
| VO 1      |          | NEWFOUNDLAND                                                     |
| VO 2      |          | LABRADOR                                                         |
| VP 1      | 7        | BELIZE                                                           |
| VP 2      | 8        | LEEWARD & WINDWARD ISLANDS                                       |
| VP 2A     | 8        | ANTIGUA, BARBUDA                                                 |
| VP 2E     | 8        | ANGUILLA                                                         |
| VP 2K     | 8        | ST. KITTS. NEVIS                                                 |
| VP 2M     | 8        | MONTERRAT                                                        |
| VP 2S     | 8        | ST. VINCENT                                                      |
| VP 2V     | 9        | BRITISH VIRGIN ISLAND                                            |
| VP 5      |          | TURKS AND CAICOS ISLAND                                          |
| VP 8      | 13       | FALKLAND. S.GEORGIA, S. ORKNEY<br>SOUTH SANDWICH IS., GRAHAMLAND |
| VP 9      | 5        | BERMUDA                                                          |
| VQ 9      | 39       | CHAGOS ISLANDS, AGALEGA ISLANDS                                  |
| VR 1      | 31       | BRITISH PHOENIX ISLANDS,<br>GILBERT & OCEAN ISLAND.              |
| VR 2      | 31       | FIJI ISLAND                                                      |
| VR 3      | 31       | NORTHERN LINE ISLAND                                             |
| VR 5      | 32       | TONGA FRIENDLY ISLANDS                                           |
| VR 6      | 32       | PITCAIRN ISLANDS                                                 |
| VR 7      | 31       | CENTRAL & SOUTHERN LINE ISLANDS                                  |
| VS 5      | 28       | BRUNEI                                                           |
| VS 6      | 24       | HONGKONG                                                         |
| VU        | 22       | INDIA                                                            |
| VU 7      | 26       | ANDAMAN AND NICOBAR IS.                                          |
| VU 7      | 22       | LACCADIVE ISLAND                                                 |
| VY 1      |          | CANADIAN YUKON                                                   |
| W         | 3-5      | U.S.A.                                                           |
| WG 6      | 27       | MARIANA ISLANDS, GAUM (NOVICE)                                   |
| WL 7      | 1        | ALASKA (NOVICES)                                                 |
| WN/WV     | 3-8      | U.S.A.(NOVICES)                                                  |
| WS6       | 32       | SAMOA U.S. (NOVICES)                                             |
| XE,XF     | 6        | MEXICO                                                           |



|         |    |                                                              |
|---------|----|--------------------------------------------------------------|
| XF4     | 6  | REVILLA GIGEDO ISLAND                                        |
| XT      | 35 | VOLTAIC REPUBLIC                                             |
| XU      | 26 | CAMBODIA                                                     |
| XV      | 26 | VIETNAM                                                      |
| XW      | 26 | LAOS                                                         |
| XZ      | 26 | MYANMAR (BURMA)                                              |
| YA      | 21 | AFGANISTAN                                                   |
| YB-YD   | 28 | INDONESIA                                                    |
| YI      | 21 | IRAQ                                                         |
| YJ      | 32 | NEW HEBRIDES                                                 |
| YK      | 20 | SYRIA                                                        |
| YN      | 7  | NICARAGUA                                                    |
| YO      | 20 | ROMANIA                                                      |
| YS      | 7  | EL SALVADOR                                                  |
| YU      | 15 | YUGOSLAVIA (Erstwhile)                                       |
| YV      | 9  | VENEZUELA                                                    |
| YVφ     | 8  | AVES ISLAND                                                  |
| ZA      | 15 | ALBANIA                                                      |
| ZB 1    | 15 | MALTA                                                        |
| ZB 2    | 15 | GIBRALTAR                                                    |
| ZC      | 20 | CYPRUS (BRITISH FORCES)                                      |
| ZD7     | 36 | SAINT HELENA                                                 |
| ZD8     | 36 | ASCENSION ISLAND                                             |
| ZD9     | 38 | TRISTAN DA CUNHA & GOUGH ISLAND                              |
| ZE      | 38 | RHODESIA                                                     |
| ZF      | 8  | CAY MAN ISLANDS                                              |
| ZK1     | 32 | COOK ISLANDS, NORTH &<br>SOUTH DANGER ISLAND                 |
| ZK2     | 32 | NIUE ISLAND                                                  |
| ZL      | 32 | NEW ZEALAND, AUCKLAND & CAMPBEL,<br>CHATHAM, KERMADEC ISLAND |
| ZL5     | 32 | NEW ZEALAND ANTARCTICA                                       |
| ZM7     | 31 | TOKELAU ISLANDS                                              |
| ZP      | 11 | PARAGUAY                                                     |
| ZR,ZS   | 38 | REPUBLIC OF SOUTH AFRICA                                     |
| ZS1     |    | SOUTH AFRICAN ANTARCTICA                                     |
| ZS2     | 39 | PRINCE EDWARD ISLANDS AND<br>MARION ISLAND                   |
| ZR3,ZS3 |    | NAMIBIA                                                      |
| 3A      | 14 | MONACO                                                       |

|       |    |                                 |
|-------|----|---------------------------------|
| 3B6   | 39 | AGALEGA ISLANDS                 |
| 3B7   |    | ST. BRANDON IS.                 |
| 3B8   | 35 | MAURITINIA ISLAND               |
| 3B9   | 39 | RODRIQUEZ ISLAND                |
| 3C    | 35 | EQUATORIAL GUINEA               |
| 3D2   | 32 | FIJI ISLAND                     |
| 3D6   | 38 | SWAZILAND                       |
| 3V    | 33 | TUNISIA                         |
| 3X    | 35 | GUINEA                          |
| 3Y    | 38 | BOUVET ISLAND                   |
| 4K1   |    | RUSSIAN ANTARCTICA              |
| 4S7   | 22 | SRILANKA                        |
| 4U    |    | UNITED NATIONS AMATEUR STATIONS |
| 4W    | 21 | NORTH YEMEN                     |
| 4X,4Z | 20 | ISREAL                          |
| 5A    | 34 | LIBYA                           |
| 5B    | 20 | CYPRUS                          |
| 5H1   | 37 | ZANZIBAR                        |
| 5H3   | 37 | TANZANIA                        |
| 5L    | 35 | LIBERIA                         |
| 5N    | 35 | NIGERIA                         |
| 5R    | 39 | MALAGASY REPUBLIC               |
| 5T    | 35 | MAURITIANA                      |
| 5U    | 35 | NIGER                           |
| 5V    | 35 | TOGOLESE REPUBLIC               |
| 5W    | 32 | WESTERN SAMOA                   |
| 5X    | 37 | UGANDA                          |
| 5Z    | 37 | KENYA                           |
| 6O    | 37 | SOMALI REPUBLIC                 |
| 6W    | 35 | SENEGAL                         |
| 6Y    | 8  | JAMAICA                         |
| 7J    |    | OKINO-TORI-SHIMA                |
| 7O    |    | SOUTH YEMEN & KAMARAN ISLAND    |
| 7P    |    | LESOTHO                         |
| 7Q    | 37 | MALAWI                          |
| 7X    | 33 | ALGERIA                         |
| 7Z    |    | SAUDI ARABIA                    |
| 8J    |    | JAPANESE ANTARCTICA             |
| 8P    | 8  | BARBADOS                        |
| 8Q    | 22 | MALDIVE IS.                     |

|       |    |                                |
|-------|----|--------------------------------|
| 8R    |    | GUYANA                         |
| 8Z4   | 21 | SAUDI ARABIA-IRAQ NEUTRAL ZONE |
| 9G    | 35 | GHANA                          |
| 9H    | 15 | MALTA                          |
| 9H4   | 15 | GOZO                           |
| 9I,9J | 36 | ZAMBIA                         |
| 9K    | 21 | KUWAIT                         |
| 9L    | 35 | SIERRA LEONE                   |
| 9M2   | 28 | WEST MALAYSIA                  |
| 9M6   |    | SABAH                          |
| 9M8   |    | SARAWAK                        |
| 9N1   | 22 | NEPAL                          |
| 9O    |    | ZAIRE                          |
| 9U    |    | SINGAPORE                      |
| 9X    | 36 | RWANDA                         |
| 9Y    | 9  | TRINIDAD AND TOBAGO            |
|       |    | □ □ □                          |

## APPENDIX VIII

### DESIGNATION OF EMISSION

| Mode                         | Designation |
|------------------------------|-------------|
| Continuous Wave (Morse Code) | A1A         |
| Modulated CW                 | A2A         |
| Amplitude Modulation (AM)    | A3E         |
| Single Side Band (SSB)       | J3E         |
| Frequency Modulated (CW)     | F2A         |
| Frequency Modulation (FM)    | F3E         |

### MAXIMUM AUTHORISED POWER

| Grade Of Licence | Power                                                                |
|------------------|----------------------------------------------------------------------|
| Restricted Grade | 10 Watts on F3E & F2A                                                |
| Grade II         | 50 Watts<br>(J3E authorisation after completion of 100 A1A contacts) |
| Grade I          | 150 Watts                                                            |
| Advance Grade    | Upto 400 Watts.<br>( in selected sub-bands)                          |